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Influences on Prescribed Burning Activity and Costs in the National Forest System

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Abstract

The results of a survey concerning National Forest System prescribed burning activity and costs from 1985 to 1995 are examined. Ninety-five of one hundred and fourteen national forests responded. Acreage burned and costs for conducting burns are reported for four types of prescribed fire: slash reduction; management-ignited tires; prescribed natural tires; and brush, grass and rangeland burns. Rankings of importance are presented for 9 resource enhancement targets, 14 potential barriers to burning, and 12 factors influencing burning costs. Survey responses concerning the presence and impact of Class I and nonattainment air quality areas am discussed. Anticipated burning levels over the next 10 years and burning levels needed to achieve desired management goals on National Forest System lands are also presented.

Keywords: Ecosystem management, environmental laws, hazard reduction, management ignited fire, national forests, prescribed natural fire.

Introduction

Recent analyses of fire policy have called for increased prescribed burning to prevent future wildfire damage and to enhance fire-dependent ecosystems and commercial forests (Bell and others 1995;[1] Mutch 1994; U.S. Department of Agriculture, Forest Service 1994; U.S. Department of the Interior/U.S. Department of Agriculture 1995;[2] Walstad and Siedel 1990). The U.S. Department of Agriculture, Forest Service (Forest Service), has set a goal of burning 3 million acres per year by the year 2010 (Bell and others 1995). Achieving such a goal will require a solid baseline assessment of current activity, wise allocation of prescribed-fire resources, and an understanding of the barriers to implementation of burning programs. Despite its ecological benefits, prescribed burning is being increasingly scrutinized and regulated as a source of air pollution (Sandberg and others 1978), traffic hazards (Mobley 1990), and escaped wildfire (Cleaves and Haines 1997, Craig 1990, Hoover 1989, Mobley 1985).

[1] Bell, E.; Cleaves, D.; Croft, H. [and others]. 1995. Fire economics assessment report. 68 p. Unpublished report. On file with: U.S. Department of Agriculture, Forest Service, Fire and Aviation Management, Sidney R. Yates Building, 201 14th Street, S.W. at Independence Avenue., S.W., Washington, DC 20250.

[2] U.S. Department of Agriculture, Forest Service. 1994. Western forest health initiative. 67 p. Unpublished report. On file with: U.S. Department of Agriculture, Forest Service, Auditors Building, 201 14th Street, S.W. at Independence Avenue, S.W., Washington, DC 20250.

An attempt to quantify burning activity on Forest Service lands, to estimate and interpret burning costs, and to identify barriers to increased burning is described in this report. The information obtained should be useful in identifying opportunities for reintroducing fire and choosing appropriate environmental, social, and economic tradeoffs.

Objectives

The objectives of this study are to (1) quantify and describe trends in the Forest Service acreage that is burned each year for silvicultural purposes; (2) identify and evaluate physical, managerial, legal, and other barriers to implementing prescribed burning; and (3) compare per-acre costs of different types of prescribed burning in different geographic and administrative regions.

Background

Legal Environment

The Federal Clean Air Act -The Clean Air Act (CAA) amendments of 1970 (P.L. 91-604) and 1977 (P.L. 95-95) gave the Federal Government responsibility for setting air-quality standards. Three provisions of the act pertain to prescribed burning: establishing national ambient air-quality standards, ensuring that States implement plans to obtain standards, and developing programs to prevent significant deterioration of air quality where pollutants exceed national standards. The CAA requires that the U.S. Environmental Protection Agency (EPA) administrator identifies and publishes a list of air pollutants and develops national ambient air-quality standards (NAAQS) for each. Primary standards are set to protect public health, secondary standards are set to protect public welfare, including property and aesthetic values. Currently, air-quality standards are in effect for six pollutants: carbon monoxide (CO), lead (Pb), nitrogen oxides (NO_x), ozone (O_3), particulate matter (PM), and sulfur oxides (SO_2).

Particulate matter (PM) is the primary pollutant resulting from prescribed fire. In July 1997, standards for particles $\leq$ 2.5 microns ($PM_{2.5}$) in diameter were set. These standards

evolved from standards based on a total suspended particle (TSP) measuring $\leq$ 40 microns (PM,,) and, more recently, standards for particles $\leq$ 10 microns (PM,,). The CAA requires that standards be reassessed every 5 years and updated if necessary. Epidemiological studies linking respiratory illnesses with fine particulate matter led the American Lung Association to file suit requiring the EPA to conduct an assessment of the PM,, standard's adequacy. Since then, the EPA has established a monitoring network and will analyze air quality for 3 years. States may begin programs to control particulate matter pollution, including PM,,,, during the monitoring period. After the monitoring phase, the EPA will identify areas not in compliance with particulate levels specified by PM,, standards. States will then be required to develop programs to improve air quality in such areas, and those programs will be subject to EPA approval. The future impact of more stringent standards on prescribed burning activity is uncertain.

Because smoke produced from prescribed burning includes high levels of tine particulates, new standards could apportion a greater share of monitored pollution to prescribed burning. For example, areas that formerly did not exceed the TSP or PM,,, standard may exceed the PM,, standard. When an area exceeds air-quality standards, regardless of the source, the use of prescribed fire may be limited in order to meet those standards (Sandberg and others 1978). The trend in tightening Federal air-quality standards may limit forest managers' options. More urban areas may be classified as nonattainment areas and, therefore, subject to greater restrictions.

Whereas the PM,, program has primarily affected the Western United States, PM,, standards could affect a significant proportion of the East. In addition, greater emphasis on regional models and standards for particulate matter on a regional scale are being considered to control pollution that is transported by air currents ii-om one airshed to another.

State implementation plans (SIP's) must contain provisions for carrying out, maintaining, and enforcing air-quality standards, including emission limits, schedules, and timetables for compliance. States have been allowed to set their own standards if they are more stringent than the Federal standards but are still required to monitor air quality and review new pollution sources.

The EPA developed its Prevention of Significant Deterioration (PSD) program to protect air quality in areas that already exceed Federal standards. The PSD describes three area classes: Class I, which severely restricts activities that would reduce pristine air quality; Class II, which restricts activities to achieve air-quality levels associated with normal, controlled growth; and Class III, which allows air quality to be maintained at levels beyond national ambient air-quality standards. Amendments were passed in 1977 to protect visibility in Class I areas, which include national parks, designated wilderness areas, and wildlife refuges. In the rule-making process, the EPA identified prescribed burning as a source of visibility pollution. It acknowledged that prescribed fire is necessary and should not be eliminated, although it did suggest that burning restrictions might be necessary in some areas.

Federal agencies-rights and responsibilities-Several Forest Service criteria regarding air quality must be met before conducting prescribed burning on Forest Service lands. Through a Forest Service national directive, smoke management must be addressed in burn plans, and risk assessments for prescribed natural fire must evaluate smoke-management concerns. In addition, prescribed-fire managers and fire-planning specialists must possess smoke-management skills when aerial ignition techniques are used. Smoke-management directives are generally issued at the regional and forest level. Criteria are developed in accordance with the CAA and State and local air-quality laws (Lahm 1990).

Section 118 of the CAA requires each Federal agency engaged in activities that discharge air pollutants to comply with applicable State and local laws and regulations to the same extent as any nongovernmental entity. In many States, documentation and permitting requirements for individual burns on National Forest System lands have been replaced by programmatic permits and memoranda of understanding. One significant impact has been in the scheduling of burns. State air-quality agencies allocate burning times for the national forests in conjunction with other burns in the airshed.

Under the Federal Tort Claims Act (FTCA) of 1946, the Forest Service can be held liable to the same extent as an individual citizen, for damages resulting from negligent acts under State statutes or common law. There are, however, several administrative procedures with which a private party must comply when making damage claims against Federal agencies.

The U.S. Supreme Court has held that when Federal forest lands are damaged by another party's fire, State forest fire laws provide protection from cases of fire trespass. As a result, State forest fire laws protect national forest lands as well as other ownership (Wiener 1995).

In addition to the Federal CAA, other environmental laws may play a role in shaping the Forest Service prescribed burning program. Rules and standards issued in accordance with natural resource protection and land-use management laws, e.g., the Endangered Species Act of 1973 (ESA), the Clean Water Act of 1977 (CWA), and the National Forest Management Act of 1976 (NFMA), as well as planning and documentation conducted in compliance with the National Environmental Policy Act of 1970 (NEPA), may impose constraints on burning.

Several managers have described how adherence to Federal, State, and local regulations has influenced organizational policies and decision-making processes. Aufenthie (1989), Carlton and Webber (1989), and Martin (1990) looked at Federal agency decision making and agreed that managers can respond to some regulations with minor adjustments, whereas other rules may have profound effects on their actions. With increasing fire and environmental regulations, fire managers are receiving conflicting directions for conducting burning practices.

Activity

A comprehensive accounting of areas treated by prescribed burning has not yet been made, nor is it known how, over time, burning purposes, organizational subdivisions, or other parameters will change. Similarly, Forest Service administrative units have only recently begun to consolidate their estimates of prescribed burning needs. Such information, as well as a characterization of the physical, social, legal, economic, and managerial factors that shape burning programs on National Forest System lands will be necessary to effectively develop expanded burning programs.

Statistics regarding acreage treated with prescribed fire are of little value without some understanding of the factors a manager must consider in making decisions about burning. Constraints on prescribed burning can be physical, e.g., degree of difficulty and danger of burning assignments and restricted time periods for safe burning; social, e.g., public acceptance and risks to residential structures; legal, e.g., laws and regulations and risk of liability; economic, e.g., cost of burning and the availability and costs of alternative treatments; and managerial, e.g., shortage of personnel or funding and organizational policies toward risk taking. The fire manager must determine how constraining those factors might be. The context of decisions to use or not to use prescribed burning typically involves the manager's unique style or perspective, as well as a combination of those factors. Without thorough knowledge of these interconnected factors and their relative importance, it is difficult to wisely allocate dollars or change institutional systems to increase the use of prescribed fire. Policymakers and managers could remove minor constraints but still fail to promote effective and safe burning programs.

Costs

There are few sources of data on the per-acre costs of burning, trends in costs, or factors influencing cost levels and variability. The total cost of prescribed burning includes components incurred during planning and layout, fire-line construction and burn preparation, ignition, and mop-up. Fixed costs include burn plan preparation, NEPA analysis and public involvement, compliance with other laws, smoke management precautions, postfire evaluation, and general overhead.

Per-acre planning costs can vary depending on operational efficiency and unit size. Project costs include firebreak construction, igniting and conducting the bum, mopping up, postfire monitoring, and contractor costs. Costs may differ from unit to unit because of differences in topography, weather conditions, and other factors. Different burning objectives also cause variations in planning, personnel and equipment needs, and the precautions that are necessary. Overall cost will reflect differences in timber types and fuels treated, safety precautions, the objectives of the bum program, overall efficiency, and cost-collection methods (Gonzalez-Cabán and McKetta 1986).

Unit size is one of the most important factors to be used in calculating per-acre costs; larger units have smaller costs, an effect well documented in the literature (Cleaves and Brodie 1990, Gonzalez-Cabán and McKetta 1986, Rideout and Omi 1995, Vasievich 1981). Costs also vary with the shape and configuration of the treatment area, especially in slash-reduction/site-preparation burns. Irregularly shaped units are more difficult to burn and monitor than more geometric units of the same size. Small and irregularly shaped units usually cost more to treat, although they may be more environmentally and aesthetically desirable. Costs may also vary among managers or organizations as a result of perceived risk (Bell and others 1995, Cleaves and Brodie 1990, Cortner and others 1990, Gonzalez-Cabán and McKetta 1986). A fire manager's perceptions can be shaped by organizational policies and standards regarding risk-taking. Decisions to use or not to use prescribed burning expose managers to multiple risks, including (1) not achieving project objectives, (2) escaped fire, (3) residual-stand damage, (4) an increased likelihood of personnel injury, (5) smoke intrusion on communities, (6) highway accidents, and (7) litigation. Fire in heavy fuel accumulations and urban interface areas risk human life and

habitation as well as entire ecosystems. Some managers incur higher costs by using more personnel and equipment to guard against escaped fire. Depending on how the burn manager perceives and assumes risk, crew allocation, scheduling of standby firefighters, fire-line standards, ignition methods, and burn/no-burn determinations may account for what seem to be excessive costs. An increasingly preferred approach to managing the use of prescribed fire is to analyze the probabilities of different outcomes under a range of strategies.

Methods

Survey

Analyses of activity levels (objective 1), constraints (objective 2), and costs (objective 3) were based on responses to a questionnaire (Appendix A) mailed to Forest Service fuels management officers (FMO's) in December 1995. For the period 1985-94, they were asked to provide estimates of the following variables: (1) the lowest, highest, and average acreage burned annually and the number of burns conducted for each of four burn types-slash reduction, management-ignited burns in natural fuels, prescribed natural fires, and brush and range burns; (2) major intended resource benefits or purpose of the burn—rated by importance from O.(no importance) to 5 (highest importance) (resource benefits include hazard reduction, reforestation, vegetation control, nongame wildlife habitat, threatened and endangered species habitat, game bird and animal habitat, insect and disease protection, grazing, and reintroduction of fire into the ecosystem); (3) historic trends and expectations in burned acreage by type of burn; (4) barriers to expanding the use of prescribed fire—rated by importance from 0 to 5, with 5 being most important; (5) the annual acreage of prescribed burning needed to achieve management goals; (6) per-acre costs of burning, broken into planning (fixed) and project (variable) costs at three levels of estimation-lowest, highest, and average; (7) factors that influence prescribed burning costs-rated for importance from 0 to 5, with 5 being most important; and (8) impact of any Class I air-quality protection areas. An open-response comment section was also included in the questionnaire.

The questionnaire was sent during the off-season to forest- and district-level fuel specialists. Contacts were made through regional fuels specialists to ensure coordination and to legitimize the request for information. During the spring of 1996, three followups by regional staffs and researchers in the USDA Forest Service, Southern Research Station's Forest Resource Law and Economics Research Work Unit were conducted by mail, telephone, Data General e-mail (Forest Service), and other e-mail.

Data from responding forests were summarized to describe status and trends for different resource mixes, types of burns, and Forest Service regions. Forest-level estimates were aggregated into regional and national totals. Average bum sizes, trends, and other parameters were compared across regions. Burned acreage was compared with burnable acreage derived from the USDA Forest Service's Forest Inventory and Analysis Research Work Units (FIA) reports by summarizing acreage in timber types that rely on periodic fire. Estimates of past and expected acreage trends were compared by burn type and region. Assessments of burning barriers were compared across regions.

Differences across forests and regions, burn types, and other parameters were interpreted using comments provided on the survey form as well as follow-up telephone interviews. Burned acreage figures were cross-checked against the annual Management Attainment Reports (MAR), which tally fuel treatment and brush disposal accomplishments. The MAR's are helpful in providing acreage by budget and activity code, but these do not provide uniform information for bum types and other parameters.

We identified our data system needs by exploring differences between estimates and the MAR records. For example, according to Southern Region fire and management operational records (the basis for their response to our survey), about half the acreage treated with prescribed fire in the southern national forests is not recorded as burned in the MAR's. The MAR's roughly identify 273,000 treatment acres that constitute wildlife habitat improvement or range management projects; the treatment method is not included in those reports.

Costs

The FMO's provided average, highest, and lowest cost estimates and apportioned those costs into planning and project categories. Project costs included burn-site preparation, ignition and maintenance, mop-up, postfire monitoring, contractor or cooperator costs, and other related activities. Planning costs included burn-plan preparation, NEPA compliance and public involvement, project planning, appeals, postfire evaluation of effects, smoke management, interdisciplinary teamwork, and general overhead.

Cost estimates were summarized and compared across burn types, regions, and other parameters. Estimates were also compared with other studies on prescribed burning expenditures, e.g., Bell and others 1995, Gonzalez-Cab&

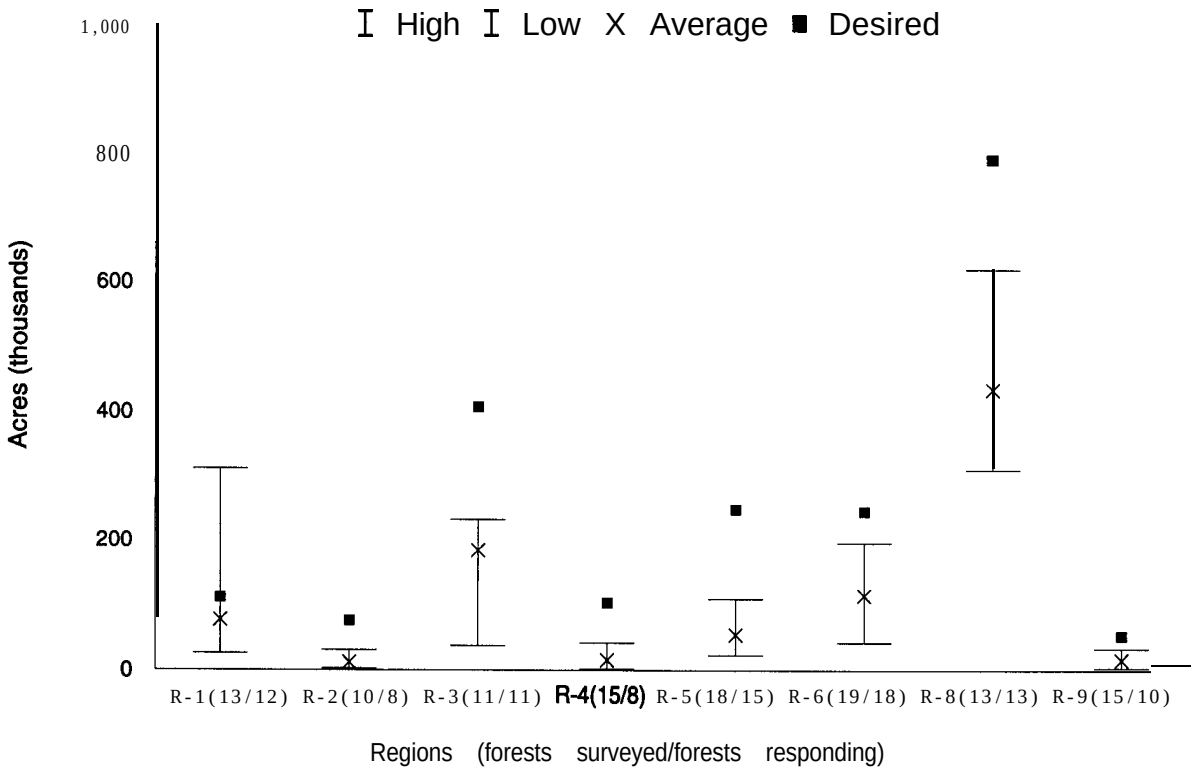

Figure I-Estimates of acres prescribed burned annually and desired burning levels, National Forest System, by region. Ranges indicate total estimates of the lowest, highest, and average activity levels. Note: Region l's high refers to eight prescribed natural tires totaling 114,269 acres in 1 year on the **Flathead** National Forest.

and McKetta 1986, **Rideout** and Omi 1995,Vasievich 1981, Wood 1988. For the Southern Region, responses were compared with past reports ***in Forest Farmer*** magazine, which periodically publishes costs for various forest practices in the South **(Dubois** and others 1995). Estimates were also compared with data from Forest Service obligation records for fiscal years 1980 through 1995 as reported by Bell and others **(1995),**[3] Cleaves and others **(1997),** and Schuster and others (1997). In those studies, per-acre expenditures were calculated for each region from the obligation data. The obligation data give detailed funding information about fuels treated with appropriated **funds,** brush disposal funds, Knutson-Vandenberg funds, and contributed or volunteer (cooperative) work. Prescribed burning benefiting Forest Service programs, such as wildlife, forest management, threatened and endangered species, recreation, range, and others, is **often** recorded under more general activity codes. The purpose of the comparison was to **confirm** overall trends and to quantify data sources.

[3] Bell, E.; Cleaves, D.; **Croft,** H. [and others]. 1995. Fire economics assessment report. Unpublished report. On file **with:** U.S. Department of Agriculture, Forest Service, Fire and Aviation Management, Sidney R. Yates Building, 201 14th Street, S.W. at Independence Avenue, S.W., Washington, DC 20250.

Results

Responses

Ninety-five of the one hundred and fourteen **FMO's** submitted usable responses. The response varied greatly by region, as shown in table 1, ranging from only 53 percent in the Intermountain Region (Region 4) to 100 percent in the Southwest and Southern Regions (Regions 3 and 8, respectively). Because no response was received **from** the Alaskan Region (Region **10),** our calculations omit this region. Nonetheless, the responding forests represent 85 percent of the land area in the National Forest System and provide a reasonable estimate of acreage trends, costs, and opinions about burn program factors. An estimate of acres burned for the entire system could be made from these data if the estimate was adjusted for the nonresponding forests. The basis of this adjustment could be obtained from MAR's reports, although they do not present the detail provided in our survey.

Activity

The average total prescribed-fue area constituted 6,763 burns and about 908,120 acres per year (fig. 1). The estimated lowest activity level was 446,999 acres in 3,429

Table l-National forests surveyed and response status, April 21, 1997

National Forests	Total acreage	Annual acreage burned	Ratio—burned-to-acreage
			Percent
Northern (Region 1)			
Beaverhead	2,128,784	3,590	0.2
Bitterroot[a]	1,580,555		0
Clearwater	1,671,485	3,540	.2
Custer	1,185,915	4,700	.4
Deer Lodge	1,194,194	2,147	.2
Flathead	2,351,761	16,748	.7
Gallatin	1,790,227	1,101	.1
Helena	975,403	2,300	.2
Idaho Panhandle	3,213,621	7,475	.2
Kootenai	1,824,544	10,587	.6
Lewis and Clark	1,862,314	12,380	.7
Lo10	2,111,223	5,452	.3
Nez Perce	2.224.056	7.166	.3
Total	24,114,082	77,186	.3[b]
Rocky Mountain (Region 2)			
Arapaho and Roosevelt	1,832,711	509	0
Bighorn	1,107,671	1,700	.2
Black Hills	1,247,132	1,600	.1
Grand Mesa-Uncompahgre and Gunnison	2,956,262	4,720	.2
Medicine Bow-Routt	2,219,314	550	
Nebraska"	141,549	—	8
Pike and San Isabel	2,227,228	590	0
San Juan-Rio Grande	3,737,089	0	0
Shoshone[a]	2,436,834		0
White River	1,961,610	2,198	.1
Total	19,867,400	11,867	.1
Southwestern (Region 3)			
Apache-Sitgreaves	2,629,745	13,850	.5
Carson	1,391,489	53,113	3.8
Cibola	1,630,709	4,732	.3
Coconino	1,846,007	25,285	1.4
Coronado	1,787,123	3,395	.2
Gila	2,708,326	29,981	1.1
Kaibab	1,558,280	9,500	.6
Lincoln	1,103,636	3,208	.3
Prescott	1,238,640	17,150	1.4
Santa Fe	1,569,495	13,283	.8
Tonto	2,873,349	10,751	.4
Total	20,336,799	184,248	.9[b]
Intermountain (Region 4)			
Ashley"	1,384,132	—	0
Boise"	2,649,366	—	0
Bridger-Teton	3,399,918	5,251	.2
Caribou"	987,351	—	0
Challis-Salmon"	4,236,638		0
Dixie	1,883,896	1,250	.1
Fishlake[a]	1,434,592	—	0
Humboldt'	2,478,902		0
Manti-La Sal	1,265,530	1,171	.1
Payette	2,323,226	6,289	.3

continued

Table l-National forests surveyed and response status, April 21, 1997 (continued)

National Forests	Total acreage	Annual acreage burned	Ratio—burned-to-acreage
			Percent
Intermountain (Region 4) (cont.)			
Sawtooth	1,803,641	104	
Targhee[a]	1643,801	—	0
Toiyabe	3,877,126	69	0
Uinta	871,237	0	0
Wasatch-Cache	1561,192	650	0
Total	31,800,548	15,412	*0*
Pacific Southwest (Region 5)			
Angeles'	655,702		*0*
Cleveland	422,731	1,550	.4
Eldorado	677,255	1,300	.2
Inyo	1,945,888	808	*0*
Klamath	1,708,736	10,050	.6
Lassen	1,059,596	5,460	.5
Los Padres	1,754,780	1,782	.1
Mendocino	886,048	4,200	.5
Modoc"	1,663,536		0
Plumas	1,171,183	5,700	.5
San Bernardino	670,381	1,435	.2
Sequoia	1,141,734	2,779	.2
Shasta-Trinity	2,203,682	6,250	.3
Sierra	1,309,013	4,500	.3
Six Rivers	988,951	2,142	.2
Stanislaus	897.712	5,995	.7
Tahoe	832,511	450	.1
Total	19,989,439	54,401	.3[b]
Pacific Northwest (Region 6)			
Colville	952,651	4,104	.4
Deschutes[a]	1,605,297	—	0
Fremont	1,201,194	15,600	1.3
Gifford Pinchot	1,310,649	6,675	.5
Malheur	1,465,396	5,086	.3
Mt. Hood	1,064,573	2,480	.2
Mt. Baker-Snoqualmie	2,521,958	1,620	.1
Ochoco	847,818	14,500	1.7
Okanogan	1,499,870	2,004	.1
Olympic	627,295	2,823	.5
Rogue River	629,241	3,167	.5
Siskiyou	1,094,655	2,867	.3
Siuslaw	631,231	2,700	.4
Umatilla	1,406,263	13,400	1.0
Umpqua	984,601	8,000	.8
Wallowa- Whitman	2,266,231	2,163	.1
Wenatchee	1,672,139	2,810	.2
Willamette	1,686,427	6,824	.4
Winema	1,040,437	17,851	1.7
Total	24,507,926	114,674	.5[b]
Southern (Region 8)			
Alabama NFs	662,715	57,155	8.6
Florida NFs	1,135,734	91,821	8.1
Mississippi NFs	1,155,338	131,687	11.4
North Carolina NFs	1,239,690	10,000	.8
Texas NFs	637,448	900	.1

continued

Table l-National forests surveyed and response status, April 21, 1997 (continued)

National Forests	Total acreage	Annual acreage burned	Ratio—burned-to-acreage
			Percent
Southern (Region 8) (cont.)			
Chattahoochee-Oconee	749,223	7,389	1.0
Cherokee	631,715	2,200	.3
Daniel Boone	539,196	2,695	.5
Francis Marion and Sumter	611,254	40,066	6.6
Kisatchie	602,308	64,773	10.8
Ouachita	1647,214	16,381	1.0
Ozark and St.Francis	154,569	7,847	.7
Washington and Jefferson	1,774,879	1,250	0
Total	12,655,924	434,119	3.4[b]
Eastern (Region 9)			
Allegheny	5 12,986	0	.0
Chequamegon	858,035	2,060	.2
Chippewa	665,694	2,200	.3
Green Mountain-Finger Lakes	367,507	310	.1
Hiawatha	893,644	800	.1
Hoosier[a]	192,804	—	0
Huron-Manistee[a]	967,237		0
Mark Twain	1,489,178	6,765	.5
Monongahela	896,382	94	0
Nicolet[a]	661,290	—	0
Ottawa	982,895	40	0
Shawne[a]	264,018		0
Superior	2,08 1,932	3,904	.2
Wayne	218,809	—	0
White Mountain	741,174	40	0
Total	11,793,585	16,213	.1[b]
Total all National Forests	165,065,703	908,120	.55

[a] Did not reply to the survey.
[b] Mean

Table 2-Average annual acres burned by National Forest System region and burn type (1985–94)[a]

National forest system	Forests surveyed responses received	Slash reduction	Management-ignited	Prescribed natural fires	Brush, range, and grassland	All types
		Acres				
Region 1	13/12	36,047	8,759	27,943	4,437	77,186
Region 2	10/08	2,970	3,580		5,317	11,867
Region 3	11/11	47,321	93,362	5,888	37,677	184,248
Region 4	15/08	4,016	4,225	2,180	4,991	15,412
Region 5	18/15	29,719	13,977	1,218	9,487	54,401
Region 6	19/18	79,319	30,899	15	4,441	114,674
Region 8	13/13	27,114	401,346	—	5,659	434,119
Region 9	15/10	3,625	8,764	574	3,250	16,213
Total	114/95	230,131	564,912	37,818	75,259	908,120

[a] Total reported includes only those forests responding to the survey.

burns, and the estimated highest activity level was 1,574,3 11 acres in 10,583 burns. The mean of the average estimated acreage ranged from 434,119 acres in Region 8 to < 11,867 acres in the Rocky Mountain Region (Region 2) and 16,2 13 in the Eastern Region (Region 9) (table 2). The difference between the estimated highest and lowest years was greatest in Region 8 at 309,557 acres, followed by the Northern Region (Region 1) at 286,240 acres, and Region 3 at 194,424 acres (fig. 1). The highest-lowest range as a percent of the average was greatest in Region 1, but most of the high activity comes from 1 year on the Flathead National Forest, where managers conducted eight prescribed natural fires totaling 114,269 acres. Different burn types displayed different activity ranges (figs. 2a through 2e). The greatest variation was in management-ignited fires.

Region 8 reported the highest annual average burned acreage at 434,119 (table 2). Region 3 was next highest at 184,248 acres, followed by the Pacific Northwest Region (Region 6) at 114,674 acres, Region 1 at 77,186 acres, the Pacific Southwest Region (Region 5) at 54,401 acres, Region 9 at 16,2 13 acres, Region 4 at 15,412 acres, and Region 2 at 11,867 acres.

The total acreage treated was not evenly distributed by bum type. Management-ignited prescribed fires accounted for most, totaling 564,912 acres or 62.2 percent of the system total (table 2), followed by slash reduction (230,13 1 acres or 25.3 percent), brush and rangeland (75,259 acres or 8.3 percent), and prescribed natural fire (37,8 18 acres or 4.2 percent). Most of the management-ignited acreage (87.6 percent) was in Regions 8 and 3. Most of the slash burning acreage (70.7 percent) was in Regions 6, 3, and 1, whereas brush and rangeland burning were conducted mainly in Regions 3 and 5 (62.7 percent).

The average burn size was 134 acres. Regions 8 and 3 conducted by far the largest burns with average sizes of 458 and 441 acres, respectively (table 3). All the other regions averaged < 90 acres.

Region 6 reported the most burns per year at 1,8 16, which were primarily for slash reduction (table 3). Region 1 followed with 1,727, Region 5 with 1,28 1, and Region 8 with 947. Overall, national forests conducted an average of 6,763 burns per year, of which 20.3 percent was management-ignited burns in natural fuels and 75.1 percent was slash-reduction burns. Slash burns were especially

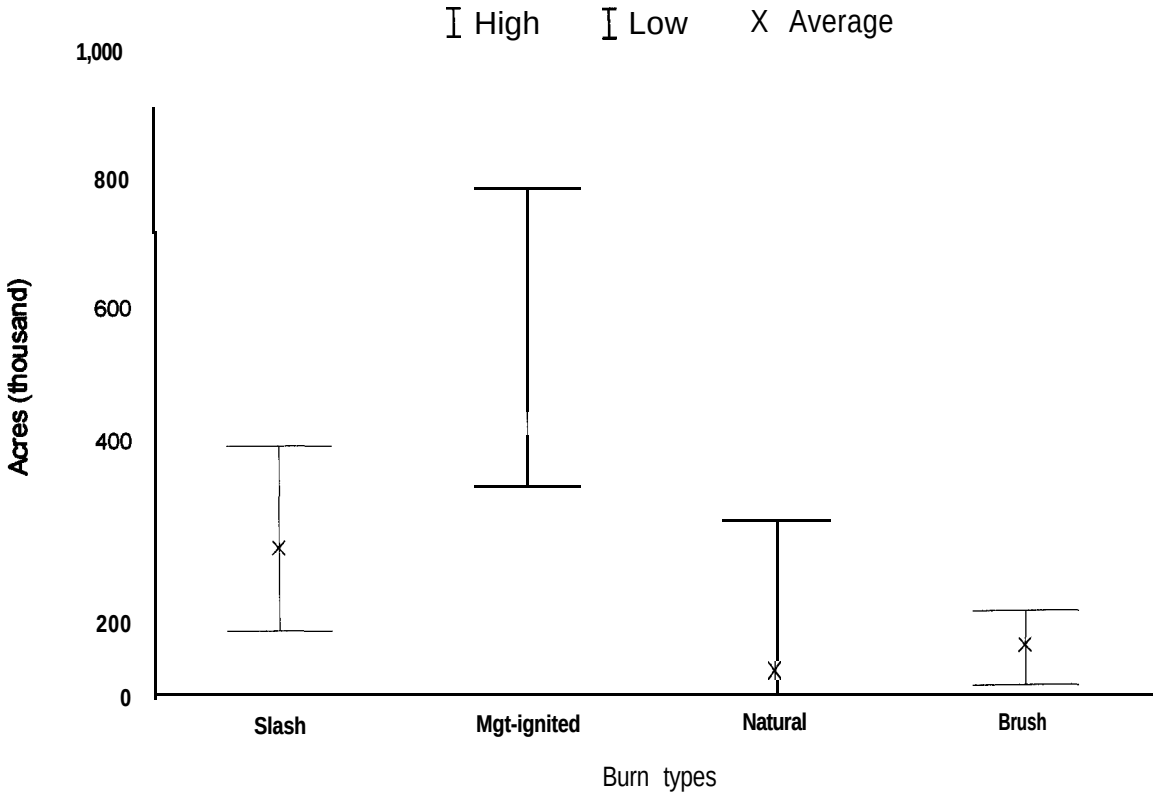

Figure 2a—Estimated ranges for total acres of prescribed burning for all burn types of all the National Forest System regions, 1985-94.

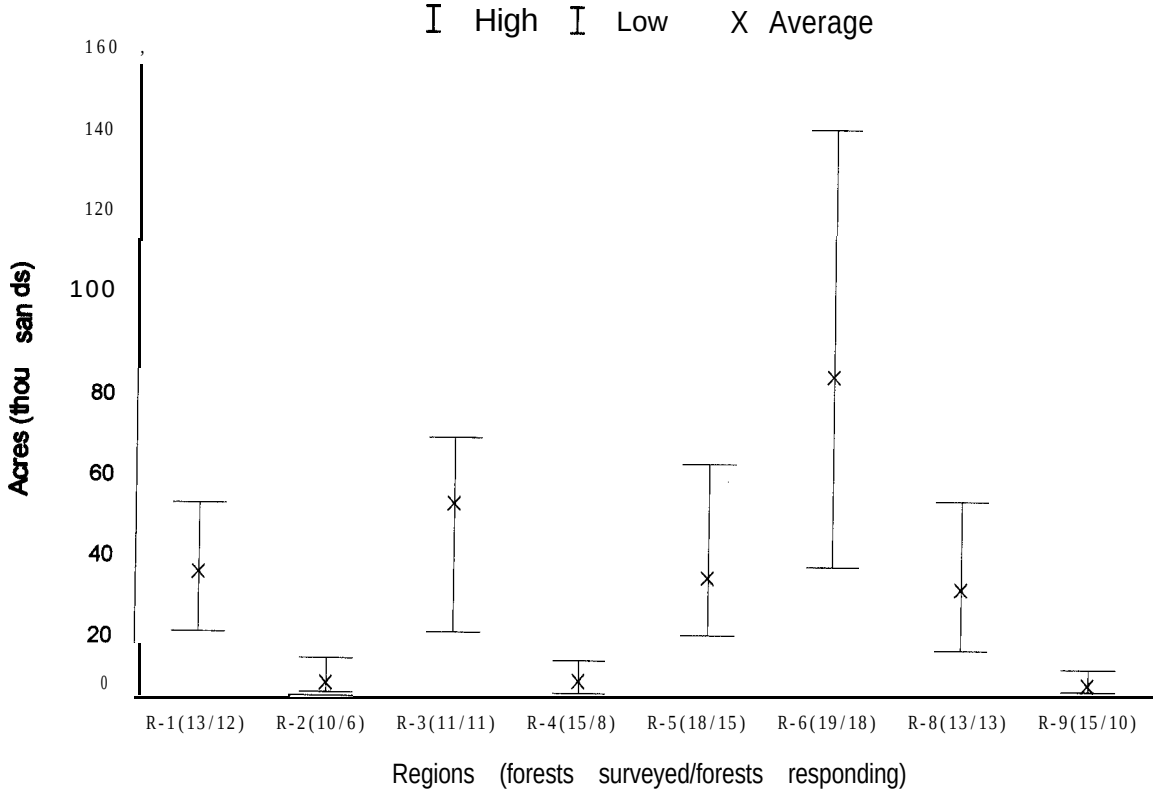

Figure 2b—Estimated total acres burned for slash reduction, by region, National Forest System. Ranges indicate total estimates of the lowest, highest, and average levels.

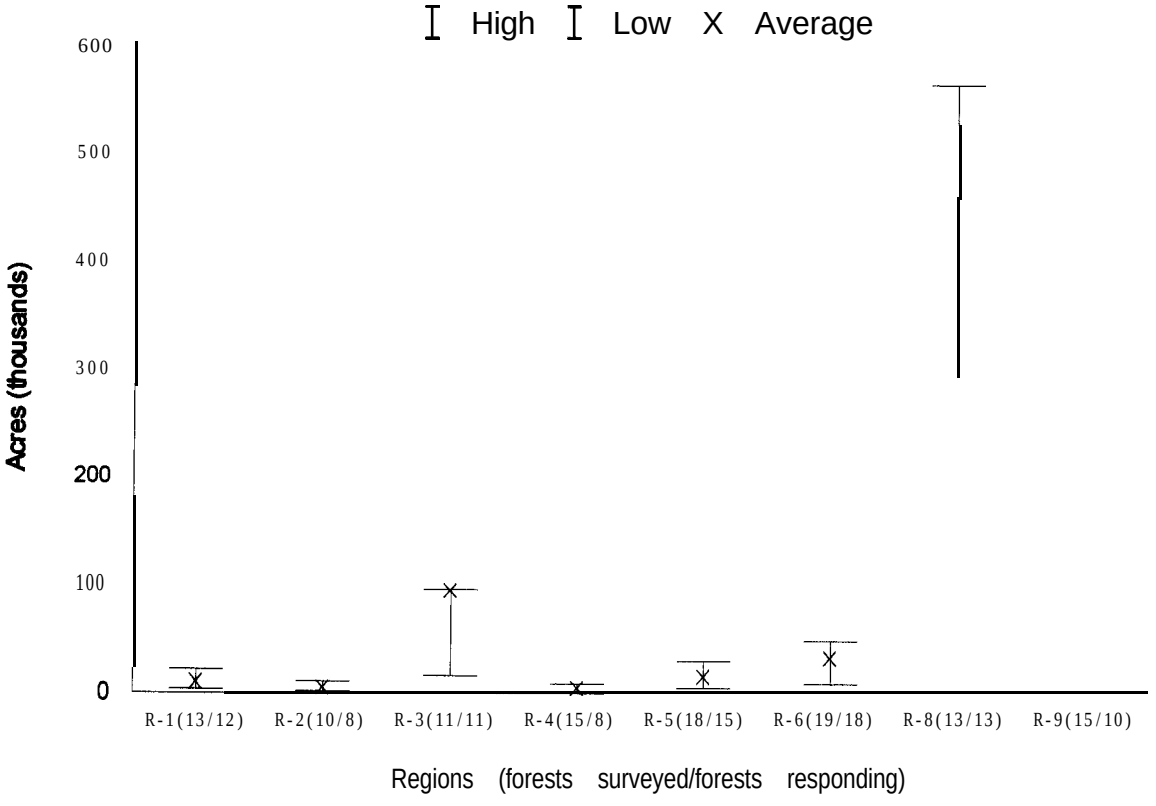

Figure 2c—Estimated total acres burned for management-ignited prescribed fires by region, National Forest System. Ranges indicate total estimates of the lowest, highest, and average levels.

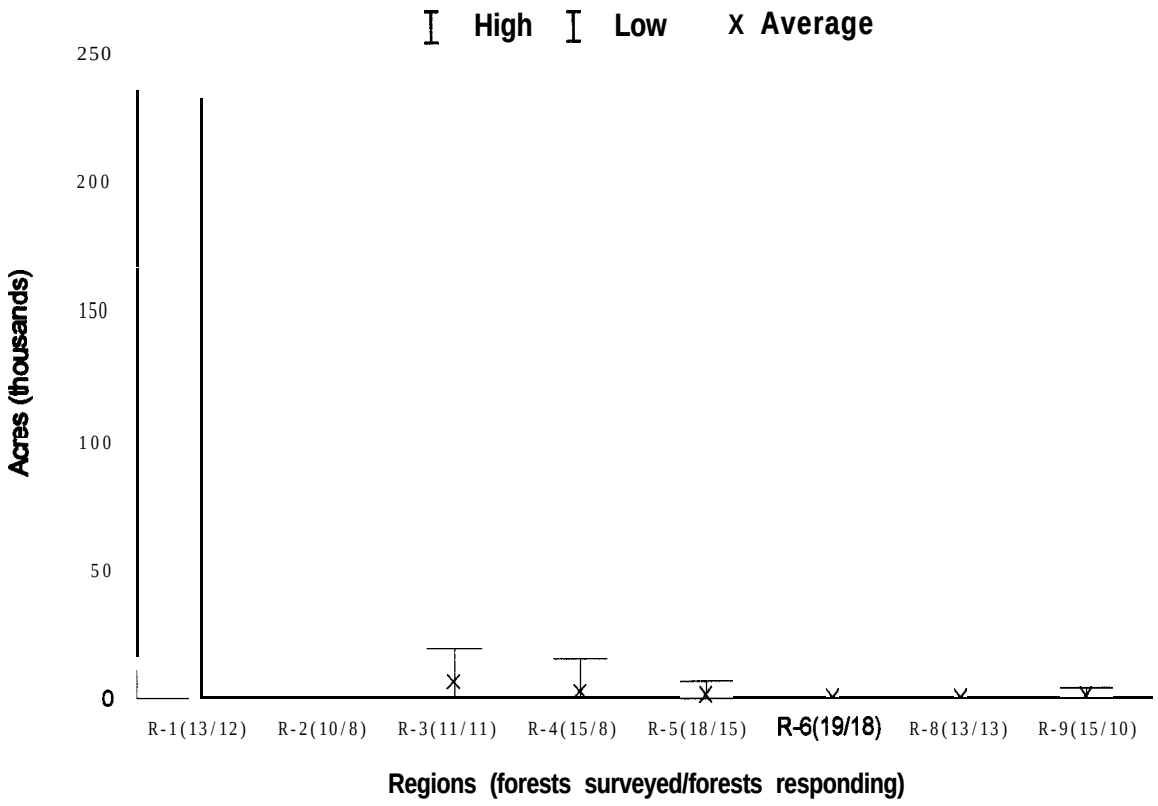

Figure 2d—Estimated total acres burned for prescribed natural fires by region, National Forest System. Ranges indicate total estimates of the lowest, highest, and average levels.

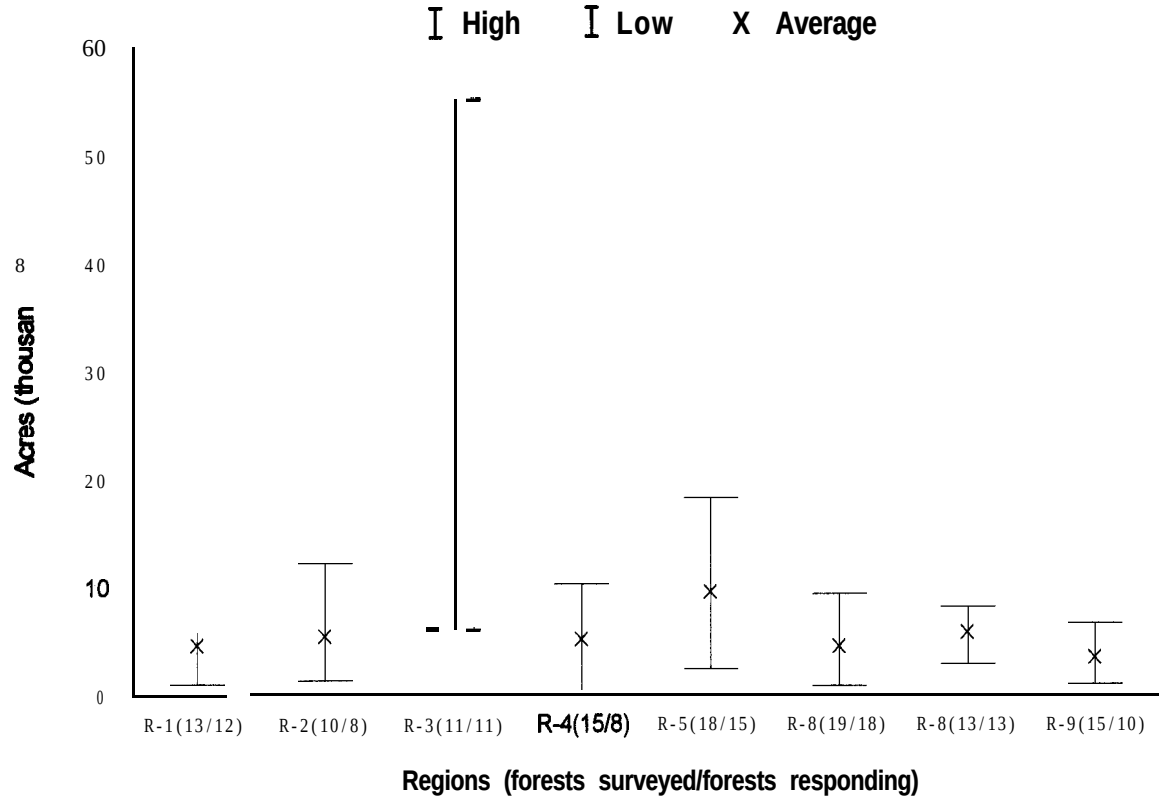

Figure 2e—Estimated total acres burned for brush, range, and grassland fuels by region, National Forest System. Ranges indicate total estimates of the lowest, highest, and average levels.

Table 3-Number of burns and average bum size, in acres, by burn type and National Forest System region (1985–94)

National Forest system	Forests surveyed / responses received	Slash reduction		Management-ignited		Prescribed natural fires		Brush, range, and grassland		All types	
		Acres/ burn	Burns/ year	Acres/ bum	Burns/ year	Acres/ burn	Bums/ year	Acres/ burn	Bums/ year	Acres/ burn	Burns.1 year
Region 1	13/12	25	1,448	38	228	1,270	22	153	29	45	1,727
Region 2	10/08	29	100	179	20	—	—	222	24	82	144
Region 3	11/11	290	163	484	193	491	12	769	49	441	418
Region 4	15/08	31	129	192	22	198	11	416	12	89	174
Region 5	18/15	27	1,106	108	129	152	8	250	38	42	1,281
Region 6	19/18	47	1,705	336	92	4	4	296	15	63	1,816
Region 8	13/13	76	359	707	568	—	—	283	20	458	947
Region 9	15/10	53	69	71	124	144	4	55	59	13	256
Total	114/95		5,079		1,376		61		246		6,763
Average		45		411		620		306		134	

common in Regions 1, 5, and 6 but averaged only about 33 acres per tire.

The largest burns were prescribed natural fires (620 acres), and the smallest were slash bums (45 acres). Management-ignited bums were the second largest (4 11 acres), followed by brush and range burns at 306 acres (table 3). This proportion of bum-type size was similar among regions. The largest prescribed natural fires were in Region 1 (1,270 acres) and Region 3 (49 1 acres). The largest brush and range fires were in Region 3 (769 acres), Region 4 (4 16 acres), Region 6 (296 acres), and Region 8 (283 acres). The largest management-ignited burns were in Region 8 (707 acres) and Region 3 (484 acres). Slash burns were the largest in Region 3 (290 acres) followed by Region 8 (76 acres). Slash burns in the other regions were small, ranging from 25 to 53 acres.

Desired Activity

Figure 1 addresses the question, "How many acres should be burned (over the next IO-year period) to achieve forest land management, fire protection, and other goals?' Estimates received from FMO's totaled 2,030,155 acres annually, more than double the average annual reported burned acreage (908,120) over the survey period. The largest difference between actual and desired burning acreage was reported for the two regions that now burn the most, Region 8 (350,88 1 acres) and Region 3 (223,252 acres). Of the total Forest Service-wide gap of 1,122,035 acres, 5 1.2 percent was accounted for in responses from Region 8 and 3.

Resource Target Mixes

Overall importance ratings ranged widely over nine resource targets: hazard reduction, reforestation, vegetation control, pest control, nongame wildlife, threatened and endangered species, game birds and animals, grazing, and the reintroduction of fire. The targets were grouped into five resource disciplines: fire, silviculture, wildlife, range, and ecosystem management. The overall importance mix for a national forest, region, or the agency as a whole varies relative to the importance assigned to the individual resource targets. Importance ratings are less valid when comparing the relative importance of a single resource target across regions because such judgments come from a variety of subunits within the Forest Service with a variety of resource concerns and internal, organizational cultures. Nonetheless, multiple resource burn plans are now the rule rather than the exception. A resource target may not be as highly rated but could nevertheless be a frequent companion to other resource targets for many, if not most, actual burns. For example, burning for hazard reduction may have concurrent wildlife and silvicultural benefits. Overall importance ratings are professional judgments about individual forest projects and do not reflect statistical data about the use of fire to accomplish management objectives. Such operational data would give a more accurate and highly stratified assessment of the agency's burning program.

Table 4-Mean ratings of relative importance for major resource objectives that would be addressed by burning programs, by National Forest System region

Resource objective	R-1 Not-them	R-2 Rocky Mountain	R-3 South-western	R-4 Inter-mountain	R-S Pacific SW	R-6 Pacific NW	R-8 Southern	R-9 Eastern	All regions
	13/12[a]	10/8	11/11	15/8	18/15	19/18	13/13	15/10	114/95
Fire									
Hazard reduction	4.58[b]	3.87	4.82	4.18	4.71	4.47	4.32	2.10	4.21
Silviculture									
Reforestation	3.73	1.87	1.68	2.80	3.15	3.31	3.21	2.30	2.85
Vegetation control'	1.82	1.73	2.95	2.30	2.33	1.88	2.89	1.80	2.26
Pest protection[d]	1.91	1.70	1.95	2.60	1.92	1.53	1.44	.90	1.71
Wildlife									
Nongame[e]	1.36	2.10	2.86	2.36	2.08	1.47	3.33	3.30	2.37
T&E species[f]	2.18	1.30	2.36	1.36	1.83	1.24	4.37	1.30	2.15
Game birds and animals	2.82	3.30	3.14	2.91	3.07	1.94	4.00	4.20	3.15
Range									
Grazing	2.18	2.30	2.91	2.27	1.25	1.12	1.42	.70	1.70
Ecosystem									
Fire reintroduction[g]	4.42	3.90	4.45	4.00	4.39	2.53	3.47	2.40	3.65

[a] Number of forests surveyed/number of forests responding.
[b] Fuels management officer's subjective assessment of resource objectives on a scale of 0 *to 5 (0 = no* importance and 5 = highest importance).
[c] Vegetation control (established stands).
[d] Pest protection: insect and disease protection.
[e] Nongame: nongame wildlife habitat.
[f] T&E species: threatened and endangered species.
[g] Reintroduction: reintroduction of fire-ecosystem management.

Hazard reduction was the most highly rated resource objective in Regions 1, 3, 4, 5, and 6 (table 4). Game and nongame habitat was the highest in Region 9, threatened and endangered species in Region 8, and ecosystem management (fuel reduction) in Region 2. Ecosystem management was the second most highly rated objective in Regions 1, 2, 3, 4, and 5. Compared with the other categories, "fire reintroduction" is a more inclusive and less exact term, which is commonly used in highly publicized communiqués on ecosystem management. These factors may have contributed to its high ranking.

Except in Regions 2 and 3, range improvement was rated fairly low. The importance of wildlife-related burning to create or enhance wildlife habitat was primarily for game and nongame species. In Region 8, however, threatened and endangered species habitat rated highest. Reforestation and game habitat were the third or fourth most important resource objectives in most regions. The lowest rated resource objective was pest management, except in Region 4. Threatened and endangered species received the most variable ratings, ranging from lowest' in importance (1.08 for Region 6 and 1.30 for Region 2) to the most highly rated objective (4.37 in Region 8).

Historical Trends in Burning Activity

The FMO's were asked to describe historical trends in burning activity for each burn type-whether annual acreage has increased, decreased, or stayed the same between 1985 and 1994 (table 5). Because of reductions in timber harvesting, slash burning decreased in more forests (60 percent) than in any other burn type. Conversely, increased fuel-treatment budgets and greater emphasis on the use of prescribed fire for silvicultural, ecosystem, and wildlife purposes resulted in a 76 percent increase in management-ignited burning. Prescribed natural fire levels remained fairly constant service wide (62 percent), whereas brush and rangeland burns increased on 43 percent of the forests, and had remained stable on 44 percent.

Table 5—Ten-year trend in prescribed burned acreage (1985-94) by National Forest System region and burn types in percentage of national forests in each region reporting each trend

Region	Forests surveyed/ responses received"	Slash reduction			Management-ignited			Prescribed natural fires			Brush, range, and grassland			All types		
		Incr.	Decr.	Same	Incr.	Decr.	Same	Incr.	Decr.	Same	Incr.	Decr.	Same	Incr.	Decr.	Same
		Percent														
1	13/12	16.7	58.3	25.0	91.7	—	8.3	58.3	—	41.7	33.3	16.7	50.0	50.0	18.8	31.2
2	10/08	33.3	44.4	22.2	88.9	—	11.1			100.0	44.4	11.1	44.4	41.7	13.9	44.4
3	11/11	9.1	72.7	18.2	81.8	9.1	9.1	100.0	—	—	81.8	9.1	9.1	68.2	22.7	9.1
4	15/08	10.0	60.0	30.0	63.6	—	36.4	25.0	25.0	50.0	62.5	12.5	25.0	40.3	24.4	35.3
5	18/15	14.3	64.3	21.4	69.2	15.4	15.4	22.2	—	77.8	27.3	9.1	63.6	33.3	22.1	44.6
6	19/18	10.5	78.9	10.5	70.6	—	29.4	46.7	—	53.3	35.7	14.3	50.0	40.9	23.3	35.8
8	13/13	36.8	47.4	15.8	75.0	5.0	20.0	—	—	100.0	33.3	20.0	46.7	36.3	18.1	45.6
9	15/10	10.0	40.0	50.0	66.7	—	33.3	20.0	—	80.0	28.6	14.3	57.1	31.3	13.6	55.1
Average		18.3	59.6	22.1	75.5	3.9	20.6	34.8	2.9	62.3	42.5	13.8	43.7	42.8	20.0	37.2

[a] There were a total of 114 forests surveyed and 95 responses received.

Table 6-Expected lo-year trend in prescribed burned acreage (1995-2004) by National Forest System region and burn type in means of subjectively assessed likelihood points[a]

Region	Forests surveyed/ responses received[b]	Slash reduction			Management-ignited			Prescribed natural fires			Brush, range and grassland			All types		
		Incr.	Decr.	Same	Incr.	Decr.	Same	Incr.	Decr.	Same	Incr.	Decr.	Same	Incr.	Decr.	Same
		Percent														
1	13/12	37.9	38.3	23.8	82.6	7.8	9.6	75.5	3.8	20.7	51.1	9.7	39.2	61.8	14.9	23.3
2	10/08	42.0	22.9	35.0	96.9	0.0	3.1	75.2	3.7	21.1	68.9	5.6	25.6	70.7	8.1	21.2
3	11/11	38.0	27.6	34.4	88.2	1.8	10.0	79.1	2.3	18.6	59.7	8.7	31.7	66.2	10.1	23.7
4	15/08	40.8	23.3	35.8	71.7	10.5	17.9	76.4	4.1	19.5	67.2	3.3	29.4	64.0	10.3	25.7
5	18/15	28.9	43.6	27.5	81.2	7.9	10.9	48.3	0.7	51.0	54.5	3.0	42.5	53.2	13.8	33.0
6	19/18	17.0	59.1	23.9	67.5	10.4	21.9	71.4	6.1	22.5	39.9	15.8	44.3	49.0	22.9	28.1
8	13/13	30.6	35.1	34.3	76.8	6.3	16.8	54.4	6.9	38.6	32.7	16.0	51.3	48.7	16.1	35.2
9	15/10	27.0	31.5	41.5	72.5	4.5	23.0	30.7	20.7	48.6	53.4	15.8	30.8	45.9	18.1	36.0
Average		31.2	37.7	31.1	78.5	6.6	14.9	66.1	5.0	28.9	51.1	10.1	38.8	56.7	14.9	28.4

[a] Each regional/burn type combination consists of the mean points allocated to each trend by the responding fuels manager, indicating his confidence level in a particular trend on a scale of 0 to 100.
[b] A total of 114 forests were surveyed and 95 responded.

Table 'I--Barriers to prescribed burning and the mean ratings by National Forest System regions, of importance of 14 influence categories (1985-94)

Barriers with influence categories	R-l Northern	R-2 Rocky Mountain	R-3 South-western	R-4 Inter-mountain	R-5 Pacific SW	R-6 Pacific NW	R-8 Southern	R-9 Eastern	All regions
	13/12[a]	10/8	11/11	15/8	18/15	19/18	13/13	15/10	114195
Social[b]									
Public opinion	4.42'	3.20	3.09	3.36	2.50	3.47	3.33	2.40	3.25
Residential	2.67	2.50	3.36	3.45	2.79	1.68	3.05	2.30	2.69
Economic[d]									
Planning costs	3.83	3.00	3.27	3.00	4.00	3.26	2.67	3.60	3.29
Funding	3.50	3.23	3.45	3.27	4.64	3.63	3.67	3.60	3.66
Alternatives	1.33	1.60	1.91	2.09	2.14	2.21	1.10	2.60	1.82
Legal'									
Regulations	3.58	3.83	4.36	3.73	3.64	3.89	4.19	2.90	3.82
Laws	3.75	2.30	3.91	3.09	3.36	3.37	2.29	2.20	3.02
Liability	3.33	3.30	2.82	3.45	3.00	2.79	3.62	3.30	3.20
Insurance	.36	.50	.70	1.33	.54	.63	.42	.44	.57
Administrative'									
Mgt. policy	2.58	2.80	2.18	3.09	2.57	2.53	2.33	2.60	2.56
Personnel	3.17	3.93	2.91	3.45	3.64	2.78	3.95	3.90	3.46
Technical[g]									
Fuel loadings	3.42	3.10	3.73	3.45	3.07	2.83	1.90	1.70	2.82
Narrow window	3.08	3.04	3.00	4.18	3.29	3.22	3.71	4.40	3.48
Uncertainty	1.25	1.22	.45	1.18	1.36	1.61	.86	2.00	1.23

[a] Number of forests surveyed/number of forests reporting.
[b] Social-public opinion: public input on the environmental effects of prescribed fire; residential: residential development in proximity of desired bum areas.
[c] Fuels management officer's subjective assessment of resource objectives on a scale of 0 to 5 with 0 = no importance and 5 = highest importance.
[d] Economic-planning costs: the overhead incurred during forest- and project-level planning; funding: lack of adequate funding; alternatives: preference for alternative silvicultural systems.
[e] Legal-regulations: air quality and smoke management regulations; laws: environmental laws protecting endangered species, water quality, archeological sites and other resources; liability: liability for smoke intrusion and escaped fires; insurance: high cost or limited availability of insurance.
[f] Administrative—management policy: management policies that discourage risk taking; personnel: shortage of qualified professionals and technicians.
[g] Technical—fuel loadings: the amount and distribution of logging slash and other dead and downed organic material; narrow window: timeframe in which prescribed burning is possible; uncertainty: not certain about the effectiveness of prescribed burning.

Expected Trends in Burning Activity

We asked the FMO's (question 3) to anticipate trends in burning over the next 10 years. They indicated the degree of certainty in their expectations by allocating 100 "likelihood points" in each of the four burn types across a range of trends: increase, decrease, or same. The points were totaled and averaged across bum types and regional categories (table 6). The systemwide mean expectation distribution for all burn types was 58 points to increase, 15 points to decrease, and 28 to stay the same. The strongest expectations for increasing acreage were in Regions 2, 3, 4, and 1.

Overall, slash burning had a likelihood of only 3 1 points for increasing. Management-ignited, prescribed natural fires, and brush and range burns had a Forest Service-wide mean likelihood to increase of 79, 66, and 5 1 points, respectively. The distributions were similar in all regions. Expectation for increasing management-ignited acreage was striking, and it was strongest in Regions 1, 2, and 3. A similar pattern emerged for prescribed natural fire (PNF). An increase was most strongly expected, especially in Regions 1, 2, 3, and 4. Only Region 9 gave a moderate likelihood (3 1 points) to the prospect of increasing prescribed natural fire. All except Regions 5 and 9 gave $\leq$ 39 points to the PNF acreage remaining the same. Brush, range, and grassland burning received its highest likelihood of increase in Regions 2, 3, and4.

Barriers to Burning

The FMO's rated 14 factors on a 5-point scale of importance, representing the degree to which each factor imposed a barrier to expanding the use of prescribed burning. We categorized the factors as social, economic, legal, administrative, and technical (table 7). Forest Service-wide, air quality and smoke management regulations

received the highest mean rating (3.8); only in Region 9 did regulations receive a mean rating of < 3.0. Lack of adequate funding was the second most important factor, with an overall mean of 3.7 and a mean rating of ≥ 3.0 in each region. Also highly rated were personnel (shortages of qualified professionals and technicians), narrow window (the prescription window for conducting burns), liability (for smoke intrusion and escaped fires), and regulations (exclusive of air quality and smoke management). Residential development and agency policies that discourage risk taking received ratings of moderate importance (2.7 and 2.6, respectively), even though these are often featured in speeches, policy issue papers, and other studies.

Funding was among the four most highly rated barriers in seven of the eight regions; air quality and smoke management regulations were among the top four barriers in six regions; and personnel was among the top four in five regions. Public opinion, planning costs, and environmental laws were among the top ranked in four regions.

The air quality and smoke management regulations category was the top-rated barrier in three of the eight regions, and a narrow prescription window was the top-rated barrier in two. The top-rated barriers in the remaining regions were public opinion, personnel limitations, and funding.

Barriers that received low ratings include alternatives to prescribed burning, uncertainty about burning as an effective fuels management practice, and the availability of insurance for prescribed burning. Excluding these three factors, the range of ratings was fairly narrow. Forest Service-wide, the mean rating of each of the remaining 11 factors was between 2.5 and 3.6. In the individual regions, the number of factors within one point of the highest ranked factor ranged from four in Region 9 to eight in Regions 2 and 4.

Patterns in the rankings differed among regions, but most FMO's perceived the nature of barriers to be more economic and legal than social, administrative, or technical. The most important of the economic factors were funding availability and planning costs. Of the legal barriers, air quality and smoke management regulations were more important than either environmental laws or liability for smoke intrusion or escaped fire. Of the administrative barriers, personnel availability was more important than the administrative policy of risk taking. The focus on technical barriers was narrowness of the burning window, which is influenced in large measure by the other legal and economic constraints.

Regional patterns about prescribed burning revealed heterogeneity in the decision-making cultures and environments. Such patterns also indicate how differently managers frame the overall problem or opportunity and suggest what reforms they might prefer in order to promote prescribed burning. As described above, some factors—funding, regulations, a limited prescription window, and personnel-were considered the most limiting in all regions. Beyond that similarity, responses for Region 1 were oriented to public opinion and economic issues, whereas Region 3 was strongly driven by legal concerns and interactions within the narrow prescription window. Region 4 appeared similarly framed in air quality and smoke management regulations and technical issues, whereas Regions 5 and 6 perceived the challenges to be more economic and legal (both air quality and environmental protection). Managers in Region 8 found the greatest challenges in air quality and smoke management, as well as in long-term personnel and funding shortages.

Costs

Overall, slash burning had the highest estimated cost per acre ($167.04), in six of the eight regions (table 8). Prescribed natural fire was the second most costly type ($103.68). However, the variability across regions was large, ranging from the least expensive treatment in some regions to the most expensive in others. Management-ignited burns ($78.13 per acre) and brush, range, and grassland burns ($57.09 per acre) were the least costly, except in Region 8.

Differences among the costs of burn types reflect differences in the blend of resource objectives, burning conditions, site characteristics, and management policies. Differences between slash-burning and management-burning costs were greatest in Region 6 ($334.02 - 77.55 = $256.47) and Region 5 ($344.46 - 223.38 = $121.08) and smallest in Regions 8 ($42.34 - 22.80 = $19.54) and 2 ($61.06 - 58.24 = $2.82). In Region 9, management-ignited burns were more expensive than slash burns by $ 18.07 per acre.

There also were differences within regions in the range of costs for a burn type. Slash burning ranged from an overall lowest of $68.24 to an overall highest of $330.72 (fig. 3a). The range (highest minus lowest) varied from $594.40 per acre in Region 1 to $31.25 in Region 8 (fig. 3b). The widest ranges for management-ignited prescribed bums (fig. 3c) were reported in Region 1 ($437.11 - 37.56 = $399.55) and Region 5 ($356.98 - 93.56 = $263.42). The smallest range was reported in Region 8 ($30.73 - 16.02 = $14.7 1). Regions 2, 3, and 4 had similar ranges-about $8 1 between the mean highest and lowest costs. This variation reflects a wide range of site characteristics, post-harvest

Table g-Estimated average cost per acre and planning cost percentage for prescribed burning, in 1994 dollars by National Forest System region and burn type (1985-94)

National Forest system	Forests surveyed/ responses received*	Slash reduction		Management-ignited		Prescribed natural fires		Brush, range, and grassland		All types	
		Per acre cost	Planning cost	Per acre cost	Planning cost	Per acre cost	Planning cost	Per acre cost	Planning cost	Per acre cost	Planning cost
		Dollars	*Percent*	*Dollars*	*Percent*	*Dollars*	*Percent*	*Dollars*	*Percent*	*Dollars*	*Percent*
Region 1	13/12	173.67	20.3	121.00	30.6	121.21	4.1	57.09	44.4	118.24	21.7
Region 2	10/08	61.06	15.6	58.24	19.0	—	—	38.81	30.0	38.53	20.4
Region 3	11/11	77.05	11.4	38.85	29.5	7.67	52.2	37.30	30.1	40.22	22.1
Region 4	15/08	81.34	16.0	34.88	24.9	133.50	5.6	19.83	37.8	67.39	13.6
Region 5	18/15	344.46	16.2	223.38	44.3	270.00	—	174.47	22.0	253.08	19.1
Region 6	19/18	334.02	19.3	77.55	42.5	85.97	35.1	55.82	48.2	138.34	27.9
Region 8	13/13	42.34	29.2	22.80	29.1	10.70	15.9	29.37	37.4	26.30	30.1
Region 9	15/10	45.60	21.9	63.67	20.1	22.00	22.7	29.38	10.6	40.16	19.3
Average		167.04	18.9	78.13	34.4	103.68	10.5	57.09	30.3	101.48	21.3

[a] A total of 114 forests were surveyed and 95 reponded.

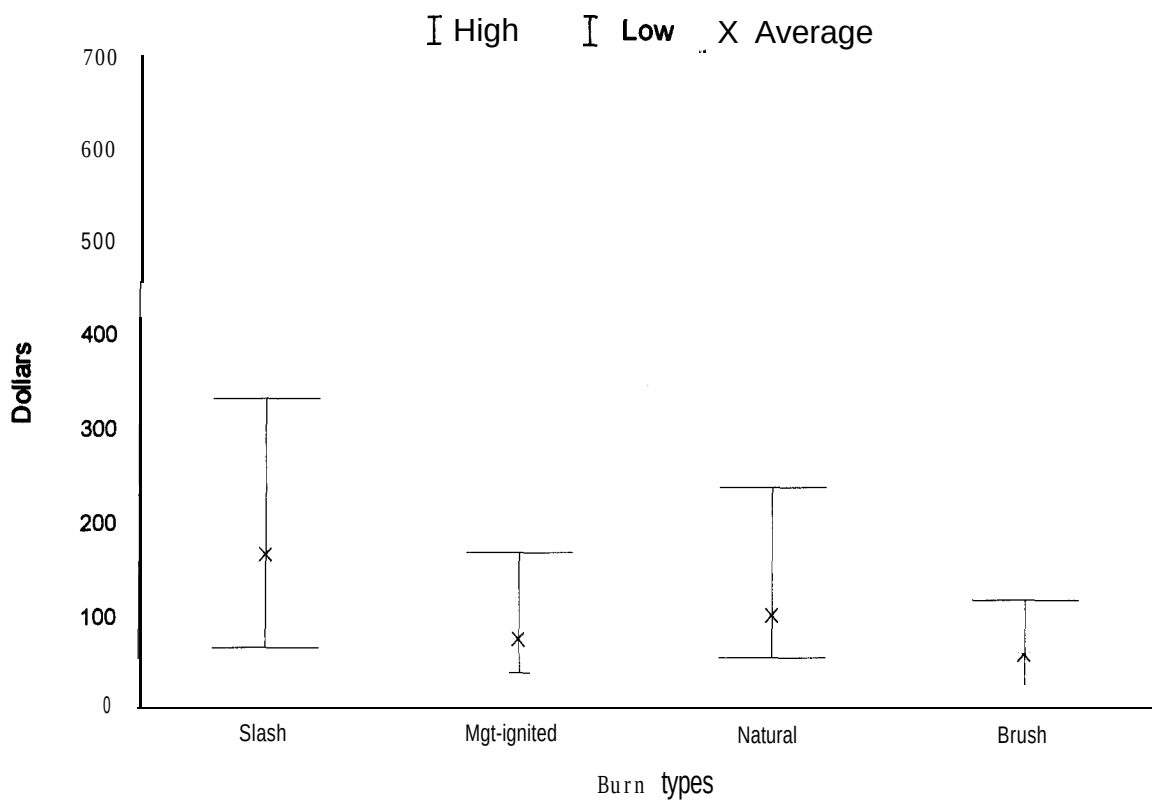

Figure 3a—Estimated ranges in costs per acre for prescribed **burning,** all **burn** types, National Forest System, in 1994 dollars, all regions, 1985-94.

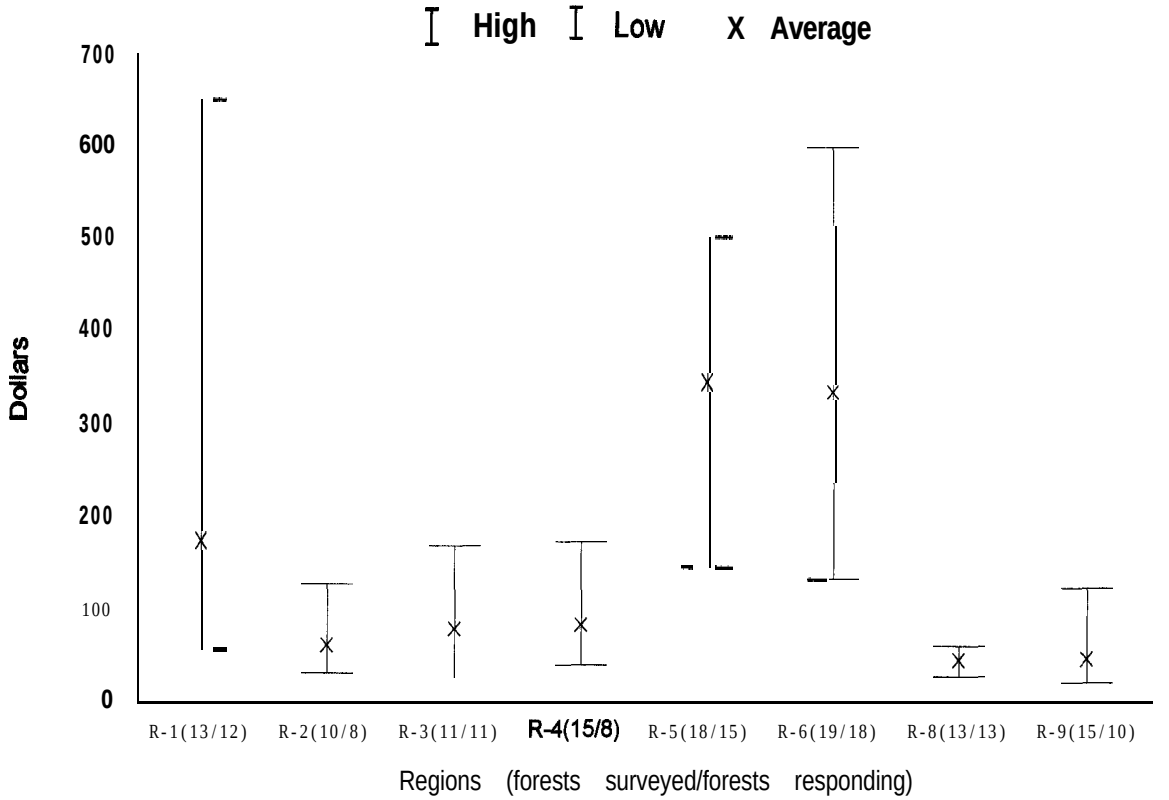

Figure 3b—Estimated total planning plus project costs per acre for slash reduction, by region National Forest System. Ranges indicate total estimates of lowest, highest, and average total cost level.

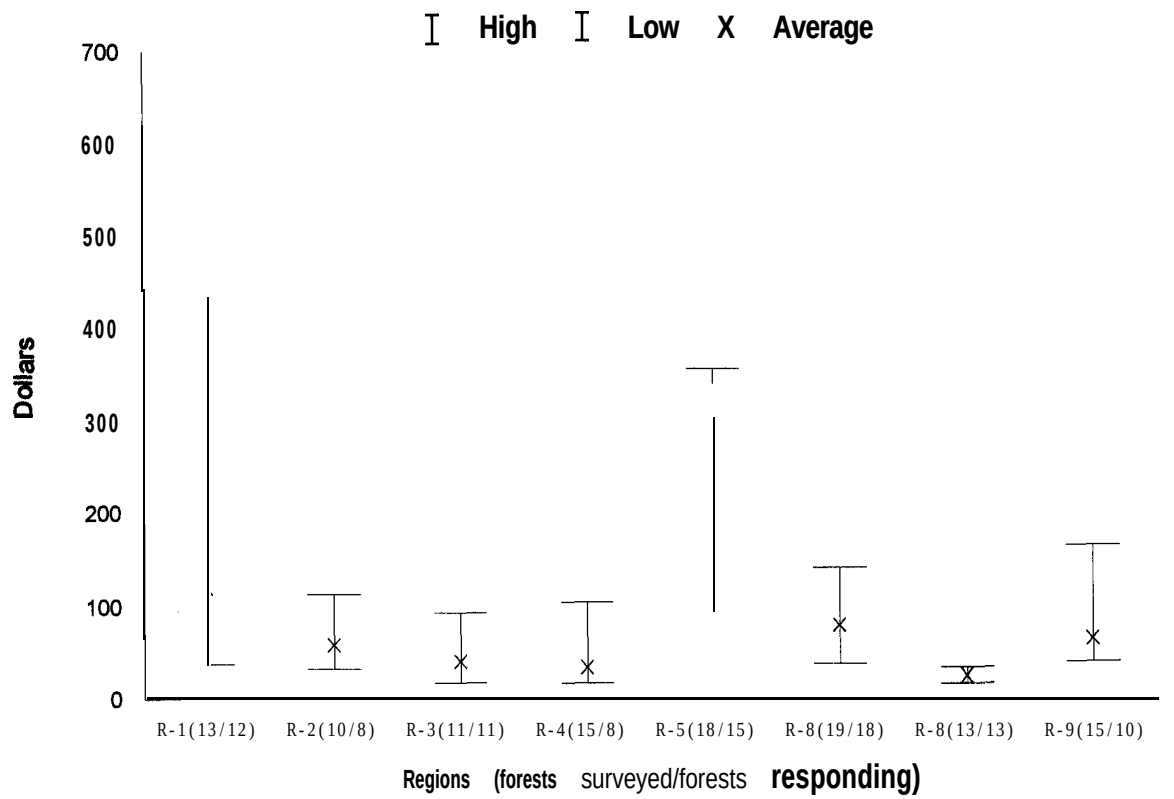

Figure 3c—Estimated total planning plus project costs per acre for management-ignited prescribed fires by region, National Forest System. Ranges indicate total estimates of lowest, highest, and average total cost level.

conditions, and multiple objectives among Forest Service harvesting and salvage units.

Management-ignited prescribed burns were the most common of burn types, responsible for more acres burned than any other. Their cost would, therefore, drive any weighted-average regional or national estimate. The Forest Service-wide mean cost, $78.13 per acre, was calculated from a regional mean of $22.80 per acre in Region 8 to $223.38 per acre in Region 5. This interregional range was much smaller than the ranges for either slash burning or prescribed natural fires.

Prescribed natural fire (fig. 3d) had the widest intraregional cost range of all bum types. However, because most regions do not have an active PNF program, these estimates may not be reliable. They are based on 61 fires per year Forest Service wide, and two regions reported no PNF's. The intraregion range in PNF costs varied from $428.75 - 53.00 = $375.75 in Region 1 to $11.75 - 9.65 = $2.10 in Region 8. In Region 5, reports of the average and lowest estimates were the same in most forests.

Brush and rangeland burning "average" costs varied from $19.83 in Region 4 to $174.47 in Region 5 (fig. 3e). The intraregional ranges were the smallest of any burn type, except in Region 5.

The largest portion of total costs (79 percent) for all burn types and regions was accounted for in project (variable cost) activities (see Methods section for definition). Planning costs accounted for 2 1 percent of the mean average cost, ranging from a low of 11 percent for PNF's to a high of 34 percent for management burns. The planning cost percentage was highest for PNF fires in Region 3 (52 percent). Planning percentage was lowest for brush and rangeland burns in Region 9 (11 percent) and slash burns in Region 3 (11 percent). Planning percentages were highest overall in Region 8 (30 percent), followed by Region 6 (28 percent). The lowest overall planning percentages were in Regions 4 (14 percent) and 5 (19 percent).

Total Cost of the Prescribed Burning Program

To estimate the total cost of the burning program, we multiplied treatment acres reported by each region and burn

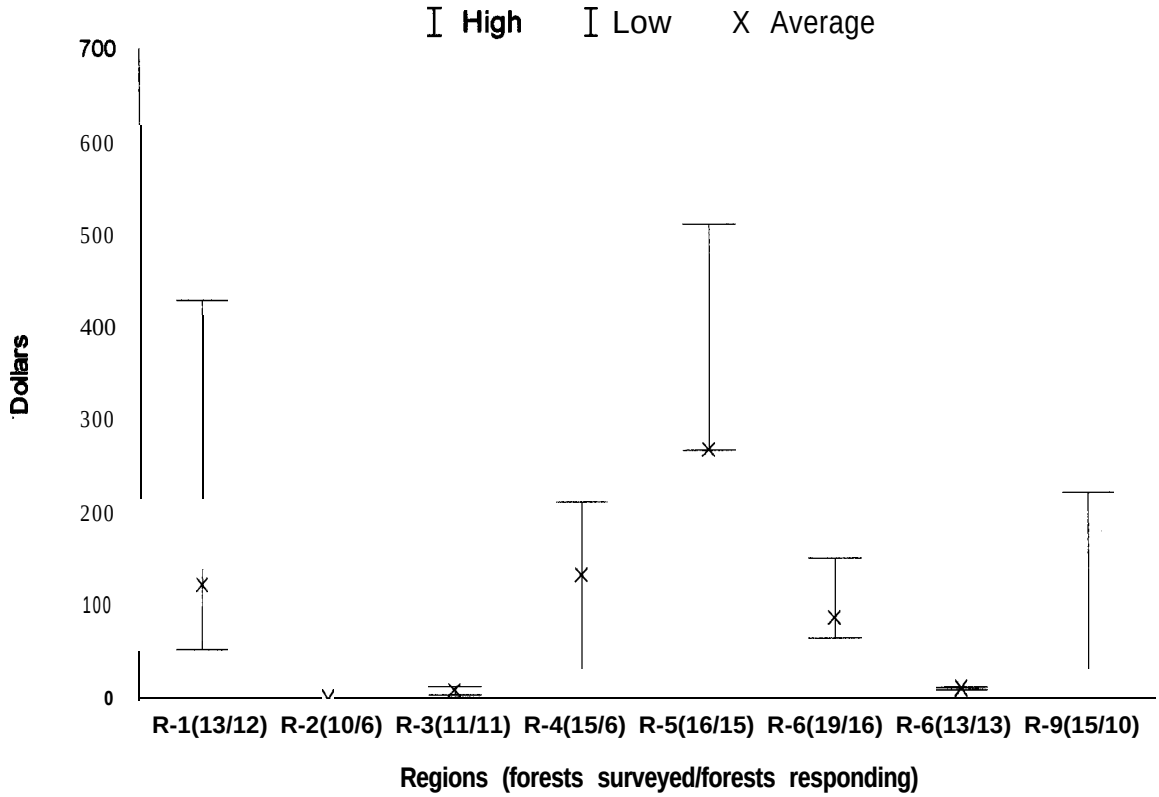

Figure 3d—Estimated total planning plus project costs per acre for prescribed natural fires by region, National Forest System. Ranges indicate total estimates of lowest, highest, and average cost levels.

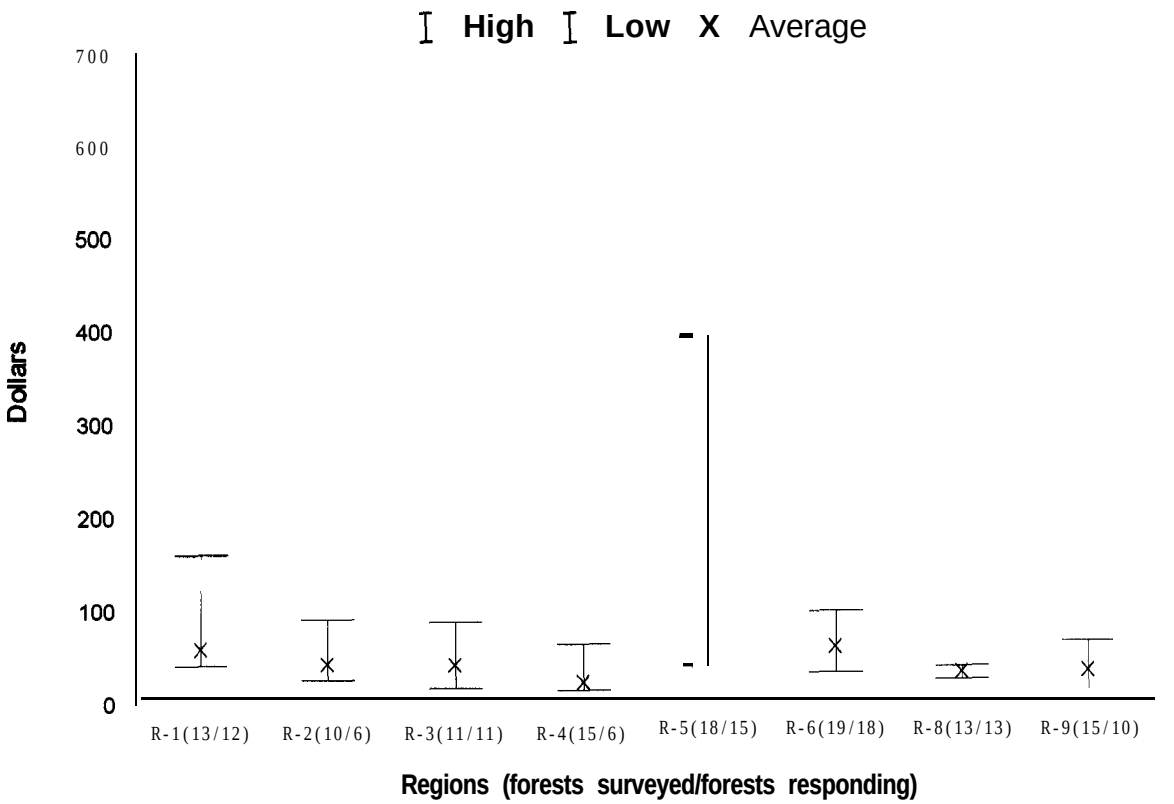

Figure 3e—Estimated total planning plus project costs per acre for brush, range, and grassland fuels by region, National Forest System. Ranges indicate total estimates of lowest. highest, and average cost levels.

type by the corresponding mean per-acre costs. The total annual cost for burning an average 908,180 acres per year was $76.9 million (table 9), most of which was incurred by Region 6 (38 percent) and Region 5 (20 percent). Most expenditures were for slash burns (63 percent) and management-ignited burns (26 percent).

These totals do not reflect the cost of to&y's burning program. Our grand average is greater than Cleaves and others (1997) and Schuster and others (1997) inflation-adjusted expenditures from appropriated fuels (FFFP) and brush disposal (BDBD) funds for fiscal years 1980 through 1995. The reported per-acre cost estimates in our survey was higher than the per-acre expenditures described in those reports. For example, for the MAR PF-2 class activity ("natural fuels burning," which is analogous to Forest Service management-ignited burns) between 1980 and 1995, Cleaves' and Schuster's reports show expenditures of $48.10 per acre. Our Forest Service-wide estimate averaged $78.13 per acre. Earlier studies' estimates (versus our estimates) were Region 1, $125.78 ($121.00); Region 2, $80.06 ($58.24); Region 3, $31.28 ($38.85); Region4, $101.39 ($34.88); Region 5, $191.42 ($223.38); Region 6, $192.72 ($77.55); Region 8, $10.97 ($22.80); and Region 9, $89.24 ($63.67). The mean estimates in this survey were not weighted by acreage in burn types or regions-they were simply the means of estimated costs. Rankings of regional averages were similar in the two data sets: Regions 1, 5, and 6 were more costly, and Regions 2, 3, and 8 were less costly.

Cur survey estimates include planning costs paid with funds other than FFFP and BDBD, including general overhead or other program functions. Project costs include those paid with funds provided by wildlife, range, and other benefiting programs. For example, about 273,000 of the 434,119 acres burned per year in Region 8 have been funded with Knutson-Vandenberg (KV) funds, timber management, wildlife, range, other resource programs, and volunteered resources. This represents an additional $3 to $4 million not reflected in Region 8's Fire and Aviation Management obligations records and the corresponding acreage not listed as fuel treatment in MAR. We were not able to determine the extent of non-FFFP and non-BDBD in the other regions. However, by comparing our survey with Cleaves and others (1997), we

Table 9-Estimated total annual costs, in 1994 thousands of dollars, for prescribed burning activity based on acreage and mean cost estimates, by National Forest System region and burn type (1985-94)

National Forest system	Forests surveyed/ responses received	Slash reduction	Management-ignited	Prescribed natural fires	Brush, range and grassland	All types
Region 1	13/12	$ 6,260	$ 1,060	$3,387	$ 253	$10,960
Region 2	10/08	181	209	—	206	596
Region 3	11/11	3,646	3,627	45	1,406	8,724
Region 4	15/08	327	147	291	99	864
Region 5	18/15	10,237	3,122	329	1,655	15,343
Region 6	19/18	26,495	2,396	1	248	29,140
Region 8	13/13	1,148	9,151	—	166	10,465
Region 9	15/10	165	558	13	96	832
Total	114/95	$48,459	$20,270	$4,066	$4,129	$76,924

can identify regions where additional acreage is being treated.

Cleaves and others (1997) reported average annual BDBD-funded acreage at 36 1,757, whereas our study reported 230,13 1 (table 2). Most of this discrepancy resulted from an absence of data, e.g., in Regions 4 and 6, a total of eight forest FMO's did not respond to our survey. The FFFP-funded (natural fuels) acreage in Cleaves and others (in press) was 336,460; our estimate was 677,989. Most of the difference in the two measures was in Regions 1, 3, and 8. Region 1 excesses reflected the use of prescribed natural fire, a burn type not recorded in MAR's. The Region 3 excesses, which totaled about 94,000 acres per year, were brush and range tires (37,677 acres) and, presumably, other fire activities not funded under FFFP. In Region 8, where we recorded 196,434 acres more than Cleaves and others (1997), the discrepancy was due largely to burning funded by other benefiting programs, primarily wildlife and threatened and endangered species. Although the FMO response rate was low in Regions 4 and 6, our acreage estimates were close to those of the earlier studies. Greater response to our survey would have substantially increased the estimate of acreage not funded by FFFP and BDBD. Several of the nonresponding national forests have well-publicized, natural fuels burning programs of tens of thousands of acres per year.

Cost Factors

Table 10 describes factors that fuels managers consider important influences to per-acre costs. In all regions, unit size and the cost and availability of labor were the two most highly rated factors. Overall, safeguards to reduce the number and severity of escaped fires and ensure compliance with environmental laws and regulations ranked third and fourth. The latter received 3.0 and higher ratings in six of the eight regions and was among the top four in Regions 1, 3, 5, 6, and 8. Escape safeguards received 3.0 and higher ratings in six regions and was among the top four factors in Regions 1, 4, 5, and 9.

Two factors received low ratings in all regions: availability of liability insurance and agency policies about risk taking. Satisfying multiple objectives, burn-unit shape, risks of liability, and residential development also were not highly rated overall but were among the four most highly rated factors in at least one region.

The rating profiles across factors and factor categories—physical, legal, inputs, risks, and management action-were similar across the regions. Regional results skew toward physical (primarily size), inputs (labor), legal, and management action (escape safeguards). Differences in regional responses showed up in the risk category. For example, in Region 2 three of the risk factors were among the most highly rated, but in Region 8 no factor in this category was so rated.

Discussion

Activity Levels

Prescribed burning is an important activity in the National Forest System; more than 900,000 acres are treated each year. It may be the most common planned disturbance, a distinction formerly held by timber harvesting. The acreage

Table 10—Parameters affecting the cost of prescribed burning and the mean ratings, by national forest region, of 12 variable influence categories (1985-94)

Resource objective	R-1 Northern	R-2 Rocky Mountain	R-3 South-western	R-4 Inter-mountain	R-5 Pacific SW	R-6 Pacific NW	R-8 Southern	R-9 Eastern	All regions
	13/12[a]	10/8	11/11	15/8	18/15	19/18	13/13	15/10	114195
Physical									
Size of the unit	3.58'	4.07	4.00	3.55	4.00	3.44	4.52	4.00	3.92
Shape of the unit	3.00	1.97	1.64	3.36	2.57	3.06	3.67	2.40	2.83
Legal									
Regulations	3.42	3.23	3.82	2.91	3.43	3.06	3.48	2.00	3.21
Inputs									
Labor	3.25	3.43	3.45	3.55	4.50	3.33	3.90	4.00	3.69
Insurance	.40	.67	1.11	1 .00	.50	.56	.32	0	.53
Risk									
Liability	3.25	3.40	2.82	3.45	2.82	2.50	2.95	3.00	2.98
Residential	2.67	3.37	4.09	3.00	3.29	1.50	3.19	2.70	2.90
Crew safety	3.08	3.30	2.91	3.64	2.71	2.94	3.05	2.60	3.02
Weather	3.50	3.40	2.55	3.91	3.21	2.82	3.12	3.10	3.17
Management action									
Objectives	3.17	2.43	2.91	3.27	3.21	3.33	2.43	1.70	2.83
Risk-taking	2.92	1.93	1.64	3.18	2.64	2.72	2.33	2.80	2.53
Escape safeguards	3.58	3.04	2.73	4.00	3.50	2.94	3.19	3.60	3.30

[a] Number of forests surveyed/number of forests reporting.
[b] Fuel management officer's subjective assessment of resource objectives on a scale of 0 to 5 with 0 = no importance and 5 = highest importance.

of natural fuels burned each year has been increasing; both management-ignited and prescribed natural fire. This activity level accelerated in the latter part of the study period, so our averages may understate what could be expected for the future. There is some uncertainty about the prescribed natural fire program; its use is controversial and has been the subject of debate on political, physical, and managerial grounds.

The FMO's who responded to our survey confirmed the need for an increased use of fire. Less than half of that need is being met, although recent increases in appropriated funds have narrowed the gap. Some were optimistic about making major progress on these goals, despite implementation barriers and cost constraints.

Many FMO's identified the shift from slash reduction to natural fuel burns as indicative of a trend toward fewer and larger burns. Although such a trend could have positive implications for per-acre costs, it might also present some problems in successfully managing resources in the wildland-urban interface, sensitive species habitats, and other protected areas. Slash and site-preparation burning have been decreasing and are expected to decrease even further. The emphasis on natural fuels may require research on new ignition and fire management techniques.

Burning helps managers achieve a variety of resource objectives. The Forest Service prescribed burning program is linked to the future of many other agency programs; e.g., wildlife, threatened and endangered species, range, and ecosystem management. Reintroduction of tire is a well-established goal in the minds of fuels managers; it is less certain whether fire reintroduction is valued more as a unique objective under new policy and program needs or as a convenient justificatory package for meeting the traditional objectives.

The issue of who pays for burning will become more critical. Multiple objectives, tighter budgets, and severe reduction in timber harvest-based funding will lead to more complex and

contentious cost and activity allocation problems. Besides a general agreement that hazard reduction is the key objective of burning, there are strong differences in regional resource objective mixes. A better articulation of these mixes and an understanding of how fire enhances resource objectives could both be used to guide future budget planning and implementation.

Barriers to Increased Burning

Air quality and smoke management regulations, funding shortfalls, narrow burning windows, and a shortage of available personnel are making it increasingly difficult to use prescribed fire. Funding and personnel shortages may become critical in the near future, especially as the wildfire-control burden increases. According to our survey, public opinion, the wildland-urban interface, potential Forest Service liability, and the agency's risk-taking policies are seen as minor compared with the complexities of dealing with diverse and often conflicting air-quality and environmental laws and forest-level standards and guidelines. The FMO's who responded may have seen the wildland-urban interface more as an objective than a constraint. Nevertheless, our survey is only exploratory and may have biased responses with our abbreviated definitions of these factors.

The FMO's prominent concern about air quality and smoke management was not surprising. The perceived importance of this barrier may be explained by a combination of factors: ambiguity about application of regulatory standards, contusion about actual restrictions on burning, and reaction to what is perceived as the specter of increasing regulations. Some FMO's may assign more weight to air quality and smoke management because of potential legal actions by interest groups or other concerned citizens.

Burning restrictions within or near PM nonattainment areas have constituted the greatest air-quality constraint. A project's nonattainment status invokes planning and notification requirements through the State air-quality agency. Several managers expressed concern about the effect of PM,, standards, which were only proposed at the time of the survey, as well as the implications of expanding human populations. If these more stringent standards had been adopted at the time of the survey, air-quality laws may have been seen as an even more important factor.

We asked whether the presence of Class I air-quality protection areas affected individual burning programs. Most of the FMO's said that their programs had not been greatly affected. Pursuant to wilderness and roadless area management policies, there is no slash or management-ignited burning in these areas; only prescribed natural fires are allowed, and they are not subject to Class I restrictions. Further, much of the prescribed burning near such areas is conducted during the fall and early spring when human use of wilderness areas and national parks is lowest. The FMO's were most concerned about the narrow prescription window for burns near Class I areas where fire can only be used when wind directions are favorable. Some cited the difficulty in documenting possible effects to Class I areas in the NEPA analysis.

Limitations to the available burning windows are a result of weather and fuel conditions and the influence of air quality regulations on the ability to schedule burns. The regulation factor could be closely correlated to the FMO's response on burning window availability if seasonal, time of day, and other scheduling rules related to air quality were viewed as highly important in assessing the air quality and smoke management factor.

Air quality regulations and environmental laws are treated as separate factors in this study. Respondents described how compliance with environmental laws can also add to the planning costs of burning, a highly rated factor (3.2). In their comments about constraints on burning as an effect of environmental laws, fire managers cited a number of issues. Many mentioned the need to provide environmental-effects documentation in compliance with the NEPA. There is little information about how many prescribed burns require NEPA analysis. However, many managers considered these requirements excessive, especially when they diverted personnel from their primary duty. National Environmental Policy Act documentation requires public "scoping" which can delay project implementation or cause missed prescription windows. Interdisciplinary planning can result in expensive or infeasible unit configuration, burn execution, and follow-up. Some FMO's expect NEPA requirements to increase, because of the trend towards large burns in natural fuels.

Federal and State regulations and Forest Service standards for species and water quality protection may also constrain prescribed tire. Standards include best management practices (BMP's) for fireline construction under the CAA and various protection measures for threatened and endangered species under the ESA. Under the NFMA, the FMO must consider species viability when planning to use prescribed fire. Burns with unacceptably high risks of escaping or of damaging species or their habitats may be postponed or cancelled. It is unclear how such risks are accounted for during burn planning and decision making.

Snag retention standards have become issues not only because snags must be protected from fire damage, but also because they post a hazard to fire crews and can serve as an ignition source. Protecting a growing network of riparian reserves and archeological sites has also complicated Forest Service burning programs.

Most FMO's did not think that agency policies toward risk taking were significant barriers, although our presentation of this factor may have confused some. In addition, there are few alternative policies for comparison: differences in regional and forest-level, decision-making processes are cultural and difficult to describe. Many FMO's may have responded to risk-taking issues in their responses to other survey questions, e.g., constrained funding and personnel-limit options for handling risk. Disciplinary action for escaped fire or accidents was not highly rated. More sophisticated studies, i.e., MacGregor (1996), can better focus on the subtle effects of policy and culture on a manager's behavior.

Costs

Data on costs were scattered and of variable quality. There is an apparent need for a uniform data collection system to track cost trends, compare cost efficiency of different burning strategies, allocate costs to benefiting programs, and use burn-unit and other parameters to predict costs (Gonzalez-Cabán and Bednor 1990, Gonzalez-Cabán and McKetta 1986).

There is some indication in our study and in Cleaves and others (1997) and Schuster and others (1997) that per-acre expenditures for natural-fuels burning have been decreasing in most regions. This is attributable to more active and larger scale burning, a growing awareness of cost determinants, and the acceptance of cost effectiveness as a decision criterion.

Unit size still has the greatest influence on per-acre cost and is influenced by many factors, including the objective's mix and risk profile. As slash burning is reduced, FMO's may have to contend less with unit sizes and shapes that have been determined by harvest-unit standards and guides.

Responses to questions about project planning costs were remarkably uniform, constituting about 25 percent of the total cost in all the regions. Our definition of planning cost included activities that would normally be fixed—those costs that would be equally distributed across the burn unit.

The use of prescribed natural fire can be expensive. That PNF's are extensively managed, "let burn" wildfires, with little cost, are not consistent with our survey results. Substantial costs are incurred in monitoring PNF's and maintaining sufficient standby personnel to respond quickly to changing burning conditions. Although such fires are typically large, their per-acre costs are high; and they require major commitments of firefighting resources at a time when there is a high demand for those nationally.

Data Limitations

Survey responses primarily reflect subjective judgments and quantified data from a variety of record-keeping systems. Prescribed burning is planned and conducted for a variety of purposes; the same data are not for different resource management functions. Some of the FMO comments on open-ended questions provide additional insight into data quality, burning activity, and costs.

To ensure that the same burn types and parameters are being compared, comparisons between or among regions should only be considered after extensive follow-up. There is great variation among responses from national forests within some regions that would require analysis to assess the statistical validity of such comparisons. Even comparisons of uniform data such as ours should not be used to assert that one region is more efficient than another. Each has a unique blend of resource objectives and physical, cultural, political, and economic-cost influences. Understanding how those elements shape the cost of burning is critical to improving cost effectiveness.

Activity data-Many forests that based their estimates on burn records reported that data for some years were not available. Most reported that 1989 was a uniformly low year because many natural fuels programs—management-ignited and prescribed natural fires-were suspended in the face of public uproar and policy reconsiderations following the Yellowstone fires. One reason for wide ranges in activity was the variability of burning conditions and resource availability during peak wildfire loads. Many estimates of "lowest" activity occurred in 1987, 1988, and 1994; but this pattern was not obvious in the data until they were compared with wildfire activity levels.

Cost data-There are few guidelines for collecting or analyzing cost data. Most uses of prescribed fire receive funding from several sources, making information retrieval and consolidation difficult and comprehensive estimates problematic. We received estimates from a variety of sources: subjective estimates, project burn plans, fire planning work sheets, ranger district records, and districtwide or forestwide rules-of-thumb. Subjective

estimates reflect many forms of judgmental bias and difficulty in estimating a 10-year average in inflation-adjusted (1994) terms. There is some disagreement about what to include as "project" or "planning" costs, although most FMO's tried to conform to our categorizations.

Slash-burn cost estimates generally included the costs of machine or hand piling and other preparation. Our crude categorization did not allow managers to show different slash preparation and ignition methods, which may have been important considerations in the ranges observed.

According to the respondents, planning-cost estimates were less certain than estimates of project costs. Fire managers have less hands-on experience with overhead activities' costs, which may only be tracked through fiscal accounting systems. Many could not estimate their planning costs. Others reported conservative estimates. Individual planning-cost estimates were as high as 60 to 70 percent. Some FMO's also said that the costs of planning were increasing, and many commented that requirements for comprehensive planning under NEPA, forest plan standards and guidelines, and environmental protection laws have increased.

Conclusions and Recommendations

Prescribed burning is probably the most extensive planned disturbance activity in the National Forest System. The agency's burning program is changing, and budgets are uncertain, yet, ambitious burning goals are being pursued. To meet burning goals, tradeoffs among resource objectives and funding sources will be necessary, as will be the allocation of fuels management dollars among regions and forests.

The General Accounting Office (GAO) has recently called on the Forest Service to develop a cohesive strategy for fuels management that reconciles stewardship objectives and overcomes implementation barriers (United States General Accounting Office 1999.) The Forest Serviceis developing that strategy at this writing.

Forest Service tire managers are gradually increasing the use of prescribed fire while holding down costs. Their efforts deserve support. Burning goals are ambitious, but fuels managers believe, attainable. A shortage of qualified personnel and uncertainties about long-term funding are barriers to progress in obtaining those goals. The burning season's narrow window of opportunity makes it doubly important that managers have a well-trained and available workforce.

There is also a need to better understand how political, managerial, and other forces influence the fire manager's behavior and the costs of burning. A more complete research design could better assess the relative importance of these factors and how they influence decision processes.

The role of environmental regulations could be better understood by conducting an assessment of the effect of laws like the ESA, CWA, NFMA, and NEPA, as well as forest-level guidelines. Such understanding would facilitate better decision making. The effects of compliance with laws and regulations need to be researched as opportunity costs, just as studies of harvesting and silvicultural investments were ma& to comply with water quality BMP's. The GAO and Congress have been conducting inquiries about Forest Service decision making and the implications of NEPA.

Such decisions would be improved if basic, comparable data on burning status and trends were available. There is a clear need for a comprehensive, uniform system of data collection on prescribed burning activities and costs beyond what is provided in the MAR reports. Further integration of land management planning with fire planning will depend on carefully selected measures and good empirical data.

A set of accepted criteria for indicators of burning performance at the program and project levels is also needed. The multiple-objective nature of burn prescription demands that such criteria be tied to those measures used to achieve the desired future conditions described in forest plans. Measures of variability, in both activity and costs, provide valuable perspectives on program performance and should be included in the displays of basic data. Ranges in costs for burn types on individual national forests should be confirmed and could be assimilated into flexible performance targets and cost-effectiveness standards.

Activity data should be collected to allow stratification by fuel type, habitat type, and other resource management land-area categories for a variety of burn types. The categories in this survey were too coarse to fully explain variations in cost, although they provided better information than is available in MAR data.

Cost data should include the expense of planning. Fuels Management Officers said they had trouble estimating those costs and, as a result, gave them less attention in making project or program decisions.

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APPENDIX A

QUESTIONNAIRE

Prescribed Burning Activity and Cost Study

USDA Forest Service

November 1995

To be filled out by forest fuel management ***officers*** *or the regional fuel management specialist.*

REGION:

FOREST:

ACTIVITY AND COST ESTIMATES SECTION

Prescribed Burning Activity

Please use DATA **TABLE-PART I** to provide us with annual activity information based on the last 10 years (1985-1994). Note that the response for natural fuels burning is divided into management-ignited and prescribed natural fires. We are assuming that all the fires in the slash-reduction and brush/grassland fires are management-ignited fires. If that assumption is incorrect, please tell us in the "COMMENTS" section how it should be corrected.

If you have information from operational databases, we would appreciate receiving summaries of year-to-year activity. If you don't have a database, we would appreciate your best judgmental estimates-about the averages and ranges. Your responses will be summarized along with those of all the other national forests. Although we have access to MAR records, they do not give us reliable estimates by forest. MAR records are organized by fund and do not tell how much of the various funds are expended on burning versus other vegetation management practices.

Costs of Prescribed Burning

Please use **DATA TABLE-PART II** to summarize your records or to estimate prescribed burning costs for the last 10 years (1985-1994). Note that we have distinguished between project costs and planning/evaluation costs . Project costs do not include the cost of suppression of burn escapes. Project costs include:

(a) preparing the burn site (e.g. firebreak construction),
(b) conducting the burns,
(c) mopping up,
(d) post-fire monitoring,
(e) contractors or cooperators costs,
(f) other activities.

Planning costs include:

(a) burn plan preparation,
(b) NEPA compliance, planning, and appeals,
(c) post-fire evaluation of effects,
(d) smoke management,
(e) interdisciplinary team and public involvement,
(f) general overhead.

Please present the planning/evaluation costs and project costs on a **per-acre** burned basis. Please make your estimates in current (1994) dollars. If you are estimating a per-acre planning cost from total cost records, please use as many years fire data as possible for your per-acre calculations.

DATA TABLE - PART I

REGION: _____

FOREST: _____

ALL FIGURES ARE FOR THE PERIOD 1985-1994	ACRES AND NUMBERS OF FIRES PER YEAR LOWEST	HIGHEST	AVERAGE
Slash Reduction	ac.	ac.	ac.
	burns	burns	burns
Natural forest fuels: Management-ignited prescribed fires	ac.	ac.	ac.
	burns	burns	burns
Natural forest fuels: Prescribed natural fires	ac.	ac.	ac.
	burns	burns	burns
Brush, range and grassland fuels	ac.	ac.	ac.
	burns	burns	burns

If these are estimates, does the period on which the estimates are based differ from the 1985-1994 period? YES ☐ NO Cl

On what data and period are these estimates based?

_____

_____

COMMENTS:

DATA TABLE - PART II

PRESCRIBED BURNING COSTS

REGION: _____

FORESTS: _____

PLANNING COSTS 1985-1994	----------COST PER ACRE---------- LOWEST	HIGHEST	AVERAGE
Slash Reduction	$	$	$
Natural forest fuels: Management-ignited prescribed fires	$	$	$
Natural forest fuels: Prescribed natural fires	$	$	$
Brush, range and grassland fuels	$	$	$

PROJECT COSTS 1985-1994	----------COST PER ACRE---------- LOWEST	HIGHEST	AVERAGE
Slash Reduction	$	$	$
Natural forest fuels: Management-ignited prescribed fires	$	$	$
Natural forest fuels: Prescribed natural fires	$	$	$
Brush, range and grassland fuels	$	$	$

What is the source of these estimates?

_____

_____

_____

On a scale of 0 to 100, how confident are you that these **reflec** actual costs of burning on your forest? *Enter a number between 0 (n confidence) and 100 (greatest confidence):* _____

BURNING FACTORS SECTION

QUESTION 1. What are the major resources targeted to benefit from the current burning program? Please rate each *of the factors below on a scale of 0 to 5, with 0 being "no importance" and 5 being "highest importance.":*

___. Hazard reduction

___. Reforestation

___. Vegetation control (established stands)

___. Non-game wildlife habitat

___. Threatened and endangered species

___. Game bird and animal habitat

- - Insect and disease protection

___. Grazing

___. Reintroduction of fire-ecosystem management

___. Other (_____)

QUESTION 2. Over the last ten years, the average annual burned acreage in the categories shown has been (please ***put an "X"*** in one *response for each burn type):*

	INCREASING	DECREASING	SAME
Slash Reduction			
Natural forest fuels: **Management-** ignited prescribed fires			
Natural forest fuels: Prescribed natural fires			
Brush, **Range** and Grassland fuels			

QUESTION 3. In your opinion, over the next ten years, how will the annual burned acreage change? *Please allocate 100 likelihood points across the trends shown, indicating your degree of certainty in your information or its interpretation. For example, putting 100 pts in **"increase"** means you are sure the annual* **acreage** *has grown. Putting 33.3 pts in each category means you think that each trend has **equal** chance* **of** *occurring. Make sure the points for all three trends* **for** *each bum type add to 100:*

Slash Reduction	pts	pts	pts	=100pts
Natural forest fuels: **Management-**ignited prescribed fires	pts	pts	pts	=100pts
Natural forest fuels: Prescribed natural fires	pts	pts	pts	=100pts
Brush, Range and Grassland fuels	pts	pts	pts	=100pts

QUESTION 4. What are the most important barriers to expanded use of prescribed burning? Please rate each *of the factors below on* **a** scale *of 0 to 5, with 0 being* ***"no*** *importance" and 5 being* ***"highest*** *importance.":*

___. Public opinion and acceptance

- - High costs of planning and implementing burns

- - Air quality and smoke management laws and regulations

___. Other federal, state, and local regulations and environmental laws (e.g. Endangered Species Act, Clean Water Act, local ordinances)

___. Risk of liability (litigation, damages, loss of public support, etc.) from smoke intrusion and escape fires

- - Lack of adequate funding to implement burning

___. Residential development in or near the areas to be burned

___. Availability of lower cost, less hazardous, or more effective alternatives to prescribed fire

- - Agency management policies that discourage line officers from accepting the risks of occasional escapes and smoke intrusions

___. Heavy fuel loadings resulting in high prescribed burning risks

___. Narrow prescription window

___. Uncertainty about burning as an effective fuels management practice

___. Shortage of qualified personnel

___. Insurance availability

___. Other (_____)

QUESTION 5. In your opinion, in spite of these barriers, for the NEXT **10-YEAR** PERIOD, how many acres **of** forest land should be prescribed burned per year in your forest to achieve land management, fire protection, and other goals?

_____ acres (1996-2006) or _____ acres per year for y e a r s .

QUESTION 6. What are the most important factors influencing the costs of prescribed burning in your forest? ***Please*** **rate each of the** *factors below on a scale of 0 to 5, with 0 being "no importance" and 5 being "highest importance.":*

____. Size of the unit being burned

____. Shape of the unit being burned

____. Compliance with environmental laws and regulations

____. Cost and availability of labor

____. Risks of liability for escape fires or **offsite** intrusions

- - Residential development in or near the units to be burned

____. Crew safety

____. Satisfying multiple objectives in burn plans

____. Agency management policies that discourage risk-taking

____. Safeguards to minimize likelihoods of escape fires

- - Unpredictability of weather conditions for burning

____. Cost and availability of insurance

____. Other (_____)

QUESTION 7. Are there any Class I air quality protection areas in or near your forest? YES ☐ NO ☐ If so, how have they impacted ***your*** burning program? *(Please explain).*

_____

_____

COMMENTS:

THANK YOU!

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Cleaves, David A.; Martinez, Jorge; Haines, Terry K. 2000. Influences on prescribed burning activity and costs in the national forest system. Gen. Tech. Rep. SRS-37. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 34 p.

The results of a survey concerning National Forest System prescribed burning activity and costs from 1985 to 1995 are examined. Ninety-five of one hundred and fourteen national forests responded. Acreage burned and costs for conducting burns are reported for four types of prescribed tire: slash reduction; management-ignited fires, prescribed natural fires; and brush, grass and rangeland bums. Rankings of importance are presented for 9 resource enhancement targets, 14 potential barriers to burning, and 12 factors influencing burning costs. Survey responses concerning the presence and impact of Class I and nonattainment air quality areas are discussed. Anticipated burning levels over the next 10 years and burning levels needed to achieve desired management goals on National Forest System lands are also presented.

Keywords: Ecosystem management, environmental laws, hazard reduction, management ignited fire, national forests, prescribed natural fire.

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